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International Aerospace Literature

During 1997 the *AIAA Journal* will carry selected aerospace literature abstracts on leading research topics from Russia, Japan, France, Germany, Italy, and the United Kingdom. The topics will be chosen and the abstracts reviewed for pertinency by *AIAA Journal* editors. This month features Microgravity Experiments from Russia, Japan, France, and Italy and Material Microstructures and Microgravity Experiments from Germany and the United Kingdom.

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Russian Aerospace Literature
This month: *Microgravity Experiments*

A97-13893 Evolution of vapor bubbles during boiling (Ehvolyutsiya parovykh puzyr'kov pri kipenii). Y. A. BUEVICH (Ural'skij Gosudarstvennyj Univ., Yekaterinburg, Russia) and B. W. WEBBON (NASA, Ames Research Center, Moffett Field, CA). *Teplofizika Vysokikh Temperatur* (ISSN 0040-3644), Vol. 34, No. 4, 1996, pp. 573–582. 17 Refs. In Russian. Documents available from AIAA Dispatch.

A new dynamic theory is proposed for the growth and separation of vapor bubbles formed on the heated surface under conditions of nucleate boiling. Equations describing an increase in the volume of a bubble and the motion of its center of gravity are obtained from the mechanical energy conservation law for the bubble-liquid system. In contrast to most other studies, no semi-empirical assumptions are made in deriving these equations. The theory proposed here explains a number of previously unexplained effects. In particular, it is found that the force due to surface tension effects contributes to bubble separation rather than inhibits it. The dependence of the bubble separation size on thermal factors and the dependence of the bubble growth rate on the dynamic factors are explained for the first time. The findings of the study are supported by experimental data on nucleate boiling under conditions of low gravity.

A96-44735 Influence of gravitation on growth rate and quality of aqueous soluble crystals. V. A. BRAILOVSKAYA, V. V. ZILBERBERG, and L. V. FEOKTISTOVA (Russian Academy of Sciences, Inst. of Applied Physics, Nizhni Novgorod, Russia). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 109–112. 9 Refs.

The modeling of solutal and forced convection in solution above the surface of growing crystal is described. The calculated flow structures and concentration fields in crystallization chamber at varying gravity are compared. The creation of the optimal hydrodynamics regime for suppressing free solutal convection and homogenization of the crystal-solution boundary layer is investigated to improve the quality of growing crystal. (Author)

A96-43966 Peculiarities of component segregation during directional crystallization of semiconductors in microgravity. V. S. ZEWMSKOV, M. R. RAUKHMAN, I. N. BELOKUROVA, and V. P. SHALIMOV (Russian Academy of Sciences, Inst. of Metallurgy, Moscow, Russia). *IAF 47th International Astronautical Congress*, Beijing, China, 1996, p. 10 (IAF Paper 96-J304). 12 Refs.

This paper analyzes the regimes and conditions of a long series of flight single-crystal growth experiments using various techniques of directional crystallization during the missions starting from Apollo-Soyuz through Salyut-6-Soyuz, and to the recent Photons. The single crystals of germanium doped with silicon, gallium, indium, antimonium, and also of indium antimonide doped with tellurium, have been grown and studied. Research results of component segregation are discussed anew for these single crystals as well as for the melt of the indium antimonide-indium bismuth system. For the first time, the results of segregation studies obtained in experiments on various spacecraft are compared with gravity conditions on these vehicles. It is shown that uncontrollable quasi-stationary microaccelerations with magnitude more than 10 exp -6 $g(0)$ are those forces leading to uncontrollable component segregation. (Author)

A96-43960 Unsteady capillary filtration through porous media in microgravity. N. N. SMIRNOV and V. R. DUSHIN (Moscow State Univ., Russia); J. C. LEGROS, E. ISTASSE, N. BOSERET, and J. C. MINCKE (Bruxelles Univ. Libre, Brussels, Belgium); and S. GOODMAN (Newfoundland, Memorial Univ., St. John's, Canada). *IAF 47th International Astronautical Congress*, Beijing, China, 1996, p. 11 (IAF Paper 96-J207). 14 Refs. Documents available from AIAA Dispatch.

Accounting for the influence of capillary forces in multiphase filtration in a porous medium renders it possible, according to the theoretical model presented, to introduce dimensionless parameters that characterize the seepage of a fluid pair through a porous medium. This is in turn suggestive of an experimental procedure for determining those rheological parameters. Such experimental investigation of capillary seepage of a wetting fluid in unsaturated porous media under reduced-gravity conditions has facilitated determination of the influence on the process of such governing parameters as pore size, fluid viscosity, and surface tension.

A96-37879 Mathematical model of MCT crystal growth from solution. A. S. SENCHENKOV (SPLAV Technical Center, Moscow, Russia). *Space processing of materials; Proceedings of the Conference*, Denver, CO, 1996 (A96-37836 10-29), Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (SPIE Proceedings. Vol. 2809), 1996, pp. 384–391. 10 Refs.

The problem of crystal growth process simulation for the cadmium–mercury–tellurium alloy from tellurium solution, via the traveling heater method, is studied under microgravity conditions. Attention is drawn to the formulation of boundary conditions at the interfaces and the calculation of the growth rate. Limitation of the local thermodynamic equilibrium approximation and uncertainty in determination of growth parameters in this case is shown. A nonequilibrium model of HgCdTe crystal growth from solution is considered which includes one matching parameter, the kinetic factor, that should be determined from experiment. Comparison of the calculation results obtained by the equilibrium and by the nonequilibrium model shows that the kinetic factor does not influence the crystal growth rate beyond a certain value. Results of the calculation of HgCdTe crystal growth process at the seed from cadmium telluride are given as well. (Author)

A96-37878 Improvement of modes crystal growth of CdTe. A. S. TOMSON (State Centre of Science "NPO Orion", Moscow, Russia). *Space processing of materials; Proceedings of the Conference*, Denver, CO, 1996 (A96-37836 10-29), Society of Photo-Optical Instrumentation Engineers, Bellingham, WA, (SPIE Proceedings. Vol. 2809), 1996, pp. 379–383. 4 Refs.

During preparation for research on processes of crystal growth in conditions of spaceflight, the processes of crystal growth in CdTe serve as a benchmark for determining the influence of such factors as a material preparation, seeding, the shape of the container, the distribution of temperature in the melt, and the speed of crystal growth, for reference geometries and sizes of monocrystals and their degree of structural perfection. Attention is here given to the effects of the structure of the liquid, which can vary depending on stoichiometric composition and mode of cooling, during the stabilization of a two-temperature annealing process for a polycrystalline load in Cd vapor. The conditions of crystal growth have yielded reproducible results. (Author)

A96-34702 Theoretical models for boiling at microgravity. L. G. BADRATINOVA (Russian Academy of Sciences, Inst. of Hydrodynamics, Novosibirsk, Russia); and P. COLINET, M. HENNENBERG, and J. C. LEGROS (Bruxelles Univ. Libre, Brussels, Belgium). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin (Lecture Notes in Physics, Vol. 464), 1996, pp. 361–370. 11 Refs.

Initial results are presented on the theoretical modeling of several aspects related to microgravity boiling. These include: the rate of phase change at

moving interfaces, the thermocapillary effect at the phase separating boundary, the influence of thermal effects on the Rayleigh–Taylor instability of a heated static vapor layer below its liquid, and the formation of the liquid macrolayer beneath vapor bubbles. (Author)

A96-23465 The centrifuge—A space technology tool on the Earth? (Tsentrifuga—Sredstvo dlya kosmicheskoj tekhnologii na Zemle?). V. P. SHALIMOV. *Lectures Devoted to the Development of the Scientific Heritage and Ideas of K. E. Tsiolkovsky, Transactions of the 28th Meeting of the Section 'K. E. Tsiolkovsky and Problems of Space Manufacturing'*, Kaluga, Russia, 1993 (A96-23449 05-12), IIET RAN, Moscow, 1994, pp. 94–103. 34 Refs. In Russian. Documents available from AIAA Dispatch.

Results of crystal growth experiments conducted in centrifuges over the past 25 years are summarized in a systematic manner. It is noted that crystal growth in centrifuges, particularly Bridgman growth with heating from the top, makes it possible to improve the structure and impurity distribution in comparison with conventional growth. Based on an analysis of the results, physical models that provide an adequate qualitative description of the experimental results are developed, including a resonance model of the effect of centrifuging on crystal growth.

A96-23462 Profile shape of thin liquid films on nonuniformly heated plates in a weak mass force field (Forma profilya tonkikh zhidkikh plenok na neravnomerno nagretykh plastinakh v slabom pole massovykh sil). N. E. BOJTSUN and V. B. SAPOZHNIKOV. *Lectures Devoted to the Development of the Scientific Heritage and Ideas of K. E. Tsiolkovsky, Transactions of the 28th Meeting of the Section 'K. E. Tsiolkovsky and Problems of Space Manufacturing'*, Kaluga, Russia, 1993 (A96-23449 05-12), IIET RAN, Moscow, 1994, pp. 80–83. 3 Refs. In Russian. Documents available from AIAA Dispatch.

Knowledge of the liquid-gas interface shape in microgravity is essential in solving problems associated with space manufacturing. The practical importance of the liquid-gas interface shape is associated with the use of liquid media with a free surface in various technological processes in microgravity. Here, a possible solution is proposed for the problem of the profile shape of thin liquid films on nonuniformly heated flat plates in a weak mass force field.

A96-23461 Indium antimonide crystal growth experiments in weightlessness (Ehksperimenty po vyrashchivaniyu kristallov antimonida indiya v usloviyakh nevesomosti). V. S. ZEMSKOV, M. R. RAUKHMAN, E. A. KOZITSYNA, I. V. BARMIN, and A. S. SENCHENKOV. *Lectures Devoted to the Development of the Scientific Heritage and Ideas of K. E. Tsiolkovsky, Transactions of the 28th Meeting of the Section 'K. E. Tsiolkovsky and Problems of Space Manufacturing'*, Kaluga, Russia, 1993 (A96-23449 05-12), IIET RAN, Moscow, 1994, pp. 72–79. 9 Refs. In Russian. Documents available from AIAA Dispatch.

Results of InSb crystal growth experiments in microgravity, conducted on both manned and unmanned spacecraft, are summarized. In particular, attention is given to the effect of microgravity on the crystallization, crystal morphology, and impurity structure and distribution in tellurium-doped InSb crystals. Calculations of heat and mass transfer in the melt during crystal growth are presented.

A96-23459 Modeling hydrodynamic processes in biotechnological plants in microgravity (Modelirovanie gidrodinamicheskikh protsessov v biotekhnologicheskikh ustanovkakh v usloviyakh mikrogravitatsii). A. A. AKSENOV, A. A. DYAD'KIN, L. I. ZVORYKINA, L. L. ZVORYKIN, and O. V. MITICHKIN. *Lectures Devoted to the Development of the Scientific Heritage and Ideas of K. E. Tsiolkovsky, Transactions of the 28th Meeting of the Section 'K. E. Tsiolkovsky and Problems of Space Manufacturing'*, Kaluga, Russia, 1993 (A96-23449 05-12), IIET RAN, Moscow, 1994, pp. 59–66. 4 Refs. In Russian. Documents available from AIAA Dispatch.

The systematic solution of hydrodynamic, electrodynamic, and electrochemical problems is essential during the design and development of electrophoresis apparatus. In particular, the size and operating regimes of an electrophoresis chamber are determined to a large degree by flow hydrodynamics within the chamber. Here, the problem of buffer solution flow in a flow-through electrophoresis apparatus is investigated.

A96-18221 On gravity dependence of polymerization. V. BRISKMAN, K. KOSTAREV, and V. MOSHEV (Inst. of Continuous Media Mechanics, Perm, Russia); L. GUSEVA (Inst. of Technical Chemistry, Perm, Russia); A. A. MASHINSKY (Inst. of Biomedical Problems, Moscow, Russia); and G. NECHITAILO (Scientific-Technical Centre Ecology and Space, Moscow, Russia). *AIAA 34th Aerospace Sciences Meeting and Exhibit*, Reno, NV, 1996, p. 8 (AIAA Paper 96-0257). 24 Refs.

A brief review of the studies performed at the Perm Scientific Center on the gravitational influence on the polymerization process is presented. By performing experiments in laboratory conditions and in centrifugal force fields, two gravitationally sensitive mechanisms were revealed: polymer globule sedimentation and convection. Both mechanisms are responsible for the occurrence of inhomogeneity in polymer products. Since they are absent in microgravity, the manufacturing of uniform polymers from liquid media in microgravity can be considered as an efficient way of obtaining uniform polymer materials. The first Mir experiments corroborated our suggestion. (Author)

A95-45957 Rotating influence on thermocapillary flow in zero-gravity state. S. N. ARISTOV (Russian Academy of Sciences, Inst. of Continuous Media Mechanics, Perm, Russia) and K. G. SHVARTS (Perm State Univ., Russia). *Microgravity Science and Technology* (ISSN 0938-0108), Vol. 8, No. 1, 1995, pp. 101–105. 8 Refs.

Circulation of the rotating shallow liquid layer in zero-gravity state and the structure of thermocapillary flows in an annular gap depending on Marangoni, Taylor, and Biot numbers is numerically investigated. The bottom and an external side-wall are heat insulative, another side-wall is heated, and the free surface is not deformed. Vortex flow arose in thin layer as a result of joint interaction between a nonuniform longitudinal temperature gradient and the Coriolis force. The compound convective motion structure is formed across the layer. (Author)

A95-45806 A study of the unsteady motion of fluids with a free boundary in cylindrical channels due to the surface tension force in a weak field of volume forces (Issledovaniya neustanovivshegosya dvizheniya zhidkostej so svobodnoj granitsej v tsilindricheskikh kanalakh pod dejstviem sily poverkhnostnogo natyazheniya v slabom pole massovykh sil). V. B. SAPOZHNIKOV. *Lectures Devoted to the Development of the Scientific Heritage and Ideas of K. E. Tsiolkovsky, Transactions of the 27th Meeting of the Section 'K. E. Tsiolkovsky and Problems of Space Manufacturing'*, Kaluga, Russia, 1992 (A95-45795 12-12), IIET RAN, Moscow, 1993, pp. 63–67. 7 Refs. In Russian. Documents available from AIAA Dispatch.

The unsteady flow of a fluid in the vicinity of a liquid-gas interface in a cylindrical tube due to the surface tension force in microgravity was investigated analytically using the approach proposed by Karnis and Mason (1967). Experiments were also conducted in a drop tower facility using ethyl alcohol, Freon-113, and diethyl ether as the working fluids, with the tube walls made of quartz and organic glasses. The results are generalized in the form of an empirical relation.

A95-45802 Bubbles in tellurium-silicon glass alloy solidification experiments in microgravity—Formation and dynamics in the melt (Puzyri v ehksperimente po zatverdevaniyu stekloobraznogo splava tellur-kremnij v usloviyakh mikrogravitatsii—Obrazovanie i dinamika v rasplave). V. P. SHALIMOV, B. T. MELEKH, I. I. FARBSHTEJN, N. K. SHUL'GA, and S. V. YAKIMOV. *Lectures Devoted to the Development of the Scientific Heritage and Ideas of K. E. Tsiolkovsky, Transactions of the 27th Meeting of the Section 'K. E. Tsiolkovsky and Problems of Space Manufacturing'*, Kaluga, Russia, 1992 (A95-45795 12-12), IIET RAN, Moscow, 1993, pp. 39–46. 12 Refs. In Russian. Documents available from AIAA Dispatch.

A study of Te-Si (80% Te, 20% Si) glass specimens produced at the crystal growth facility on the Mir space station has shown the presence of pores in the material related to the formation of gas bubbles in the melt. In this connection, gas release processes in Te-Si melts is investigated with emphasis on the effect of gravity. The dynamics of gas bubbles in Te-Si melts is also examined with allowance for gravity, buoyancy, viscous friction, and capillary and other forces acting in the absence of convection.

A95-45801 Bubble formation and dynamics in indium antimonide containerless zone melting experiments in microgravity (Obrazovanie i dinamika puzyrej v ehksperimente po beskontejnernoj zonnoj plavke antimonida indiya v usloviyakh mikrogravitatsii). V. P. SHALIMOV, V. S. ZEMSKOV, M. R. RAUKHMAN, and E. A. KOZITSYNA. *Lectures Devoted to the Development of the Scientific Heritage and Ideas of K. E. Tsiolkovsky, Transactions of the 27th Meeting of the Section 'K. E. Tsiolkovsky and Problems of Space Manufacturing'*, Kaluga, Russia, 1992 (A95-45795 12-12), IIET RAN, Moscow, 1993, pp. 31–38. 16 Refs. In Russian. Documents available from AIAA Dispatch.

Results of past space experiments involving the crucibleless zone melting of tellurium-doped indium antimonide indicate the formation of several gas pores near the longitudinal axis of specimens recrystallized in a magnetic field. Here, the possibility the formation of gas pores in experiments on InSb as well as the characteristics and behavior of the pores are analyzed. It is shown that the gas pores observed in Te-doped InSb crystals are produced by vapor bubbles formed in the melt under nonequilibrium conditions.

A95-45800 Directional solidification of complex Si/Al-Ni/Al-Cu/Ge eutectic alloys—A joint Chinese-Russian space experiment (ground simulations) (Napravlennaya kristallizatsiya kompleksnykh ehvtekticheskikh splavov Si/Al-Ni/Al-Cu/Ge—Sovmestnyj kitajsko-rossijskij kosmicheskij ehksperiment (nazemnaya obrabotka). V. P. SHALIMOV, A. M. TURCHANINOV, M. B. SHCHERBINA-SAMOJLOVA, S.-S. CHEN', M.-S. PAN, L.-C. SIN', and S.-C. CHEN. *Lectures Devoted to the Development of the Scientific Heritage and Ideas of K. E. Tsiolkovsky, Transactions of the 27th Meeting of the Section 'K. E. Tsiolkovsky and Problems of Space Manufacturing'*, Kaluga, Russia, 1992 (A95-45795 12-12), IIET RAN, Moscow, 1993, pp. 24–30. 6 Refs. In Russian. Documents available from AIAA Dispatch.

Results of ground simulations of experiments on the directional solidification of Si/Al-Ni/Al-Cu/Ge eutectics, which are considered for inclusion in the program of experiments to be conducted at the Mir space station using the onboard crystal growth facility, are reported. Results of the ground experiments indicate that the structures produced in different growth direction relative to the *g* direction are essentially different, i.e, the processes investigated are gravity-sensitive. Based on the results of the simulations, the experiments are recommended for the Mir station program.

A95-21470 A system for analysis and measurement of convection aboard space station—Objectives, mathematical and ground-based modeling. G. P. BOGATYRYOV and G. F. PUTIN (Perm State Univ., Russia); M. K. ERMAKOV, S. A. NIKITIN, D. S. PAVLOVSKY, and V. I. POLEZHAEV (Russian Academy of Sciences, Inst. for Problems In Mechanics, Moscow, Russia); and A. I. IVANOV and S. F. SAVIN (NPO Energia, Russia). *AIAA 33rd Aerospace*

Sciences Meeting and Exhibit, Reno, NV, 1995, p. 10 (AIAA Paper 95-0890). 13 Refs.

A simple device using a connection between orbital flight accelerometer data and thermal convection in enclosure data for benchmarking and evaluation of low frequency accelerations is proposed. This paper presents objectives and ground-based experimental and numerical modeling of this device, as well as benchmarking and discussion of the option of the 'working media'. The influence of small inclinations and small amplitude swaying on thermal convection inside the cubic cavity with the edge 3 cm filled with air and heated from above in stationary and periodic regimes are investigated both experimentally and numerically. (Author)

A95-21287 Comparative experimental research of polymerization on the 'Mir' orbital station and on the Earth. V. BRISKMAN, K. KOSTAREV, and T. YUDINA (Inst. of Continuous Media Mechanics, Perm, Russia) and V. LEVTOV and V. ROMANOV (SPA Kompozit, Moscow, Russia). *AIAA 33rd Aerospace Sciences Meeting and Exhibit*, Reno, NV, 1995, p. 8 (AIAA Paper 95-0263). 17 Refs.

Comparative experimental investigations of gravity sensitive mechanisms of polymerization on the Earth and on the Mir orbital stations are described. In terrestrial conditions, the convective flows were found to have a strong effect on the process of polyacrylamide gel photopolymerization. The orbital experiment has shown that convective flows are absent and the conversion degree front propagates with the rate defined by the light absorption laws for the media in the quiescent state. (Author)

A95-14476 'Round table' discussion (materials processing in microgravity environment) (Diskussiya 'kruglogo stola'). *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1994, pp. 163–170. In Russian. Documents available from AIAA Dispatch.

The 'round table' discussion reviewed here was concerned with mechanics models for investigating manufacturing processes in microgravity. The discussion covered a variety of topics, including the effect of vibrations on crystal growth in microgravity, suppression of convective instabilities, coordination of materials science experiments in space, new trends in metallurgical experiments in space, and processes in cryogenic fuel tanks.

A95-14474 Free convection and temperature stratification in a cryogenic fuel tank in microgravity (Estestvennaya konvektsiya i temperaturnaya stratifikatsiya v kriogennom toplivnom bake v usloviyakh mikrogravitatsii). S. G. CHERKASOV. *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1994, pp. 142–149. 11 Refs. In Russian. Documents available from AIAA Dispatch.

A model is proposed for calculating the temperature stratification of cryogenic fuel inside a tank in a spacecraft. The model is based on the integral representation of equations of a free-convection boundary layer. Calculation results are compared with numerical solutions of the Navier–Stokes equations and experimental data.

A95-14473 Bubble formation in a tellurium-silicon melt in microgravity and bubble dynamics (Obrazovanie puzyrej v rasplave tellur—kremnij v usloviyakh mikrogravitatsii i ikh dinamika). B. T. MELEKH, I. I. FARBSHTEJN, V. P. SHALIMOV, N. K. SHUL'GA, and S. V. YAKIMOV (RAN, Fiziko-Tekhnicheskij Inst., St. Petersburg, Russia). *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1994, pp. 135–141. 13 Refs. In Russian. Documents available from AIAA Dispatch.

Results of space and ground-based experimental studies of $Te_{80}Si_{20}$ melt solidification are discussed, with particular attention given to the formation of gas voids in the ingots. The possibilities for degassing are examined. The bubble generation process, the dynamics of bubbles in the melts investigated, and gravitational effects are treated theoretically.

A95-14471 Behavior of a liquid and a gas-liquid system in microgravity (Osobennosti povedeniya zhidkosti i sistemy zhidkost'—gaz v usloviyakh, blizkikh k nevesomosti). A. M. VETOSHKIN, A. V. KOROL'KOV, and V. V. SAVICHEV. *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1994, pp. 123–128. 8 Refs. In Russian. Documents available from AIAA Dispatch.

Results of recent studies of the behavior of a liquid under conditions of thermal gravitational convection in internal, external, and coupled problems under conditions of nearly zero gravity are generalized. Results of flow calculations in a liquid-gas system in a variable acceleration vector field are presented.

A95-14469 Convection in an oscillating force field and microgravity (Konvektsiya v ostsilliruyushchem pole sil i mikrogravitatsiya). S. Y. GERTSENSHTEJN and A. I. RAKHMANOV. *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1994, pp. 99–106. 8 Refs. In Russian. Documents available from AIAA Dispatch.

Convective motions in a plane layer of a viscous liquid in the presence of an external oscillating force are investigated numerically. The motions of the liquid are described by Navier–Stokes equations using the Boussinesq approximation. The flows generated in the presence of a transverse temperature gradient and the stability limits of these flows are determined; the supercritical regimes are examined. The analysis employs the averaging approach and the Galerkin method.

A95-14465 A study of the effect of weightlessness on convection and mass transfer during crystal growth from aqueous solutions (Issledovanie vliyaniya nevesomosti na konvektsiyu i massoobmen pri roste kristallov iz vodnykh rastvorov). V. A. BRAJLOVSKAYA, V. V. ZIL'BERBERG, and L. V. FEOKTISTOVA. *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1994, pp. 62–66. 12 Refs. In Russian. Documents available from AIAA Dispatch.

Results of the modeling of crystal growth from aqueous solutions under normal gravity and in weightlessness are presented and compared. The effect of microgravity on the homogeneity of the boundary layer adjacent to the surface of a growing crystal is investigated. It is shown how the results of the modeling of crystal growth in microgravity can be used to estimate the parameters that are characteristic of the optimized solution hydromechanics under terrestrial conditions.

A95-14464 Convective flows in a cylindrical liquid zone in a high-frequency vibration field (Konvektivnye techeniya v tsilindricheskoj zhidkoj zone v vysokochastotnom vibratsionnom pole). G. Z. GERSHUNI, D. V. LYUBIMOV, T. P. LYUBIMOVA, and B. RU. *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1994, pp. 53–61. 7 Refs. In Russian. Documents available from AIAA Dispatch.

An analysis is made of convective flows of a nonuniformly heated liquid in a cylindrical liquid zone in a field of high-frequency axial vibrations. In particular, attention is given to vibration frequencies that are high in comparison with dissipation decrements and capillary frequencies and low in comparison with acoustic frequencies. The interaction between the flow vibration mechanisms and thermocapillary effects on the free surface is examined.

A95-14463 Production of semiconductor layers in microgravity under conditions of slow cell rotation (Poluchenie sloev poluprovodnikovykh materialov v usloviyakh mikrogravitatsii i pri medlennom vrashchenii yachejki). N. A. VEREZUB and V. I. POLEZHAEV. *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1994, pp. 46–52. 14 Refs. In Russian. Documents available from AIAA Dispatch.

The hydrodynamic processes occurring in the melt during the growth of epitaxial layers of semiconductor materials are investigated using mathematical modeling methods in an attempt to identify convective mass transfer effects in liquid epitaxy and find ways to control these effects. Results of the modeling of convection and mass transfer using parameters characteristic of epitaxial growth of III–V semiconductors are presented.

A95-14462 Materials processing equipment onboard the Foton unmanned satellite and some experimental results (Tekhnologicheskoe oborudovanie avtomaticheskogo sputnika Foton i nekotorye rezul'taty ehksperimentov). I. V. BARMIN and A. S. SENCHENKOV. *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1994, pp. 37–45. 7 Refs. In Russian. Documents available from AIAA Dispatch.

The materials processing facilities used for crystal growth experiments onboard the Foton satellite are described. Results of microgravity crystal growth experiments, in which single crystals of CdTe, CdSeTe, CdZnTe, Ge, InSb, and GaSb were grown by the crucibleless zone melting method, are reported. Experiments are also described in which semiconductor crystals were grown by the method of a moving heater in a rotating magnetic field.

A95-14461 Microacceleration regimes, gravitational sensitivity, and methods for the analysis of materials processing experiments in weightlessness (Rezhimy mikrouskorenij, gravitatsionnaya chuvstvitel'nost' i metody analiza tekhnologicheskikh ehsperimentov v usloviyakh nevesomosti). V. I. POLEZHAEV. *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1994, pp. 22–36. 43 Refs. In Russian. Documents available from AIAA Dispatch.

Methods for measuring and calculating the spatial-temporal variations of microaccelerations onboard space stations and new methods for the analysis of materials processing experiments in space using models of convective heat and mass transfer are reviewed. Attention is given to the gravitational sensitivity of convective processes and effects of macro- and microinhomogeneities produced by various types of convection. The discussion also covers the problem of coupling between a computer program based on nonstationary Navier–Stokes equations and an accelerometer for estimating microaccelerations.

A94-32633 Polymerization under different gravity conditions. V. BRISKMAN and K. KOSTAREV (Russian Academy of Sciences, Inst. of Continuous Media Mechanics, Perm, Russia); V. LEVTOV (SPA 'Kompozit', Kaliningrad, Russia); T. LYUBIMOVA (Russian Academy of Sciences, Inst. of Continuous Media Mechanics, Perm, Russia); A. MASHINSKIJ (Inst. of Biomedical Problems, Moscow, Russia); G. NECHITAJLO (SPA 'Energiya', Moscow, Russia); and V. ROMANOV (SPA 'Kompozit', Kaliningrad, Russia). *IAF 45th International Astronautical Congress*, Jerusalem, Israel, 1994, p. 12 (IAF Paper 94-257). 18 Refs.

The paper reviews research into influence of body forces on polymerization at three qualitatively different gravity levels: microgravity, terrestrial and high gravity conditions. In orbital conditions the photopolymerization of polyacrylamide gel (PAG) was found to be developing as a frontal process in stagnant liquid. Terrestrial experiments and mathematical modeling have demonstrated the existence of convective flows and their strong influence both on structuration and on the final PAG structure. Experiments in centrifugal field and numerical calculations performed for high gravity conditions revealed that the gel matrix properties are graded along the body force direction. (Author)

Japanese Aerospace Literature
This month: *Microgravity Experiments*

A97-12316 Spray cooling characteristics of water and FC-72 under reduced and elevated gravity for space application. K. SONE, K. YOSHIDA, and T. OKA (IHI, Yokohama, Japan); Y. ABE (Electrotechnical Lab., Tsukuba, Japan); and Y. MORI and A. NAGASHIMA (Keio Univ., Yokohama, Japan). *IECEC 96; Proceedings of the 31st Intersociety Energy Conversion Engineering Conference*, Washington, DC, 1996, Vol. 2 (A97-12170 01-44), Inst. of Electrical and Electronics Engineers, Piscataway, NJ, 1996, pp. 1500–1505. 4 Refs.

For application to space thermal management systems, spray cooling characteristics under both reduced and elevated gravity conditions have been experimentally studied with the aid of the parabolic flights of an aircraft, the MU-300, during each of its parabolic flights and also during the entry and recovery periods of each parabolic trajectory. Water and FC-72 were employed as the test liquids to be sprayed, and the spray parameters for each liquid were controlled by alternately using three different spray nozzles and adjusting the injection pressure at a prescribed level. Detailed observations from the rear side of the transparent heater were set up so that the behavior of the impinging droplets on the heater surface could be recognized. A remarkable difference was found in the gravity dependence of spray cooling characteristics between water and FC-72. Observations through the transparent heater indicated that the difference in the low heat flux region is mainly ascribable to a difference between the two liquids in the behavior of liquid layer formed on the heater surface. (Author)

A96-44748 Dendritic growth in undercooled melt with forced convection. Y. MIYATA and T. UMEMURA (Nagaoka Univ. of Technology, Japan). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 209–214. 5 Refs.

A theory of dendritic growth is proposed with flow in the undercooled pure melt, and the predictions are successfully compared with experimental results. Analytical solutions for melt flow with Oseen viscous flow approximation are given for the Navier–Stokes equations in the region near the tip of a dendrite. Temperature is also analyzed in the presence of flow in a melt. The local equilibrium condition at the interface is applied in the theory. The predicted growth rate of the tip of the dendrite as functions of melt undercooling with and without forced flow is successfully compared with experimental results for the pure succinonitrile. (Author)

A96-43977 Effect of liquid bridge form on oscillatory thermocapillary convection under normal gravity and microgravity conditions—Drop shaft experiments. M. SAKURAI, N. OHISHI, and A. HIRATA (Waseda Univ., Tokyo, Japan). *IAF 47th International Astronautical Congress*, Beijing, China, 1996, p. 8 (IAF Paper 96-J406). 11 Refs.

This study is in regards to the effect of the temperature difference between the hot and the cool disk (δ-T), and the non-dimensional liquid bridge volume [$V/V(0)$] on the transition process from steady thermocapillary convection to periodic or chaotic thermocapillary convection in a liquid bridge modeled after the floating zone method under normal gravity and microgravity conditions. From normal gravity and drop shaft experiments, the difference between the regime of the steady state and the oscillatory state was clarified on the δ-T-$V/V(0)$ plane under 1 g and micro-g conditions. A gap or stability region was observed in the specific $V/V(0)$ range under 1-g conditions. In the gap or stable region, after the gravity changed from 1-g to micro-g conditions, the temperature signals showed oscillation. From these results, the critical temperature difference under the micro-g conditions appeared to be smaller than that under the 1-g conditions. Temperature signals were defined as six different types of states. The various temperature oscillatory state regimes were obtained on a δ-T-$V/V(0)$ plane under 1-g and micro-g conditions. Under micro-g conditions, in these experimental conditions, all temperature oscillatory states exhibited only the periodic state. (Author)

A96-37880 Development of electrostatic levitation furnace for the International Space Station. T. ISHIKAWA, K. MURAKAMI, and S. YODA (NASDA, Tsukuba, Japan). *Space processing of materials; Proceedings of the Conference*, Denver, CO, 1996 (A96-37836 10-29), Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (SPIE Proceedings. Vol. 2809), 1996, pp. 392–399. 3 Refs.

An electrostatic levitation furnace (ELF) is under development for the Japanese Experiment Module in the International Space Station, which will be operational around 2000. This paper describes the features and development status of the ELF, and some expected experiments which use the ELF's containerless processing environment. These will encompass nonequilibrium solidification, measurements of thermophysical properties, surface tension and viscosity, and the production of high performance materials. (Author)

A96-37486 Estimation of interaction between two bubbles in a liquid oscillating by *g*-jitter in space. H. AZUMA (National Aerospace Lab., Chofu, Japan). *Proceedings of the 19th International Symposium on Space Technology and Science*, Yokohama, Japan, 1994 (A96-37401 10-12), Agne Shofu Publishing, Inc., Tokyo, Japan, 1994, pp. 671–675. 6 Refs.

The migration speed of a bubble in a liquid subject to g-jitter is estimated. The interaction between an oscillating bubble and a wall is analyzed by two methods based either on potential flow or viscous flow, depending on the skin depth of the oscillating bubble. Numerical results are obtained and compared to data from a sounding rocket experiment. (Author)

A96-37484 Pneumatic solid particles conveying experiment under the microgravity. O. MURAGISHI, K. TSUTSUMI, Y. SAKAKIDA, and T. KAWAMURA (Kawasaki Heavy Industries, Ltd., Akashi, Japan) and S. CHIBA, H. TAKEUCHI, and Y. OYAMA (Hokkaido National Industrial Research Inst., Sapporo, Japan). *Proceedings of the 19th International Symposium on Space Technology and Science*, Yokohama, Japan, 1994 (A96-37401 10-12), Agne Shofu Publishing, Inc., Tokyo, Japan, 1994, pp. 657–665. 8 Refs.

The flowing behavior of solid particles running through a straight tube was observed under microgravity using a drop shaft. Under microgravity, it was confirmed that conveying with low gas velocity is possible and that the particles flow straight with laminar flow of gas. A device which feeds solid particles for space use was manufactured by a trial experiment, and its operation under microgravity was demonstrated. The device has a special structure taking microgravity effects in account. In this paper, the results of flowing particle observations and the demonstration of the manufactured feeder are reported. (Author)

A96-37482 Experimental study on nucleation of fine particles synthesized by chemical reaction from the vapor phase under microgravity. S.-I. KAMEI, H. NAKAMURA, and M. ISHIKAWA (Mitsubishi Research Inst., Inc., Tokyo, Japan). *Proceedings of the 19th International Symposium on Space Technology and Science*, Yokohama, Japan, 1994 (A96-37401 10-12), Agne Shofu Publishing, Inc., Tokyo, Japan, 1994, pp. 647–650. 4 Refs.

An experimental study on the chemical synthesis of TiO_2 fine particles from $TiCl_4$ and H_2O vapor was performed by measuring the light scattered from the particles under microgravity conditions for 10 s utilizing a drop tower. It was seen that the production rate and the number of the particles synthesized under microgravity were much smaller than for the 1 g condition and that the size distribution of synthesized particles was much sharper in microgravity. This strongly suggests that the nucleation rate might be smaller under the microgravity condition. (Author)

A96-37480 An experimental study of subcooled boiling from wires in micro-gravity. I. TOKURA and Y. HANAOKA (Muroran Inst. of Technology, Japan); H. SUZUKI (Toyo Engineering Corp., Japan); H. HIRATA (Inst. for Unmanned Space Experiment Free Flyer, Tokyo, Japan); and M. YONETA (New Energy and Industrial Technology Development Organization, Tokyo, Japan). *Proceedings of the 19th International Symposium on Space Technology and Science*, Yokohama, Japan, 1994 (A96-37401 10-12), Agne Shofu Publishing, Inc., Tokyo, Japan, 1994, pp. 629–633. 3 Refs.

Boiling heat transfer experiments were conducted on thin wires in subcooled methyl alcohol under a microgravity condition of 0.0001 G by using the drop shaft of JAMIC. Two different types of boiling were observed in the experiments. Small bubbles spring out of the wire when the heat flux is low. This shows that a certain radial force acts on the bubbles even in microgravity. In high heat flux conditions, the generated bubbles coalesce and form large spherical bubbles that envelop the wire. This results in time-dependent heat transfer characteristics in microgravity. Boiling heat transfer in microgravity of 0.0001 G is inherently an unsteady phenomenon. (Author)

A96-32561 Research in large isothermal furnace. S.-I. YODA (NASDA, Tsukuba, Japan). *Strengthening cooperation in the 21st century; Proceedings of the 6th International Space Conference of Pacific Basin Societies*, Marina Del Rey, CA, 1995 (A96-32532 08-12), American Astronautical Society, San Diego, CA (Advances in Astronautical Sciences. Vol. 91), 1996, pp. 319–331 (AAS Paper 95-588).

NASDA participates in MSL-1 (Microgravity Science Laboratory—1) with seven experiments, including two U.S. experiments with the Large Isothermal Furnace, and develops the experimental technology necessary for microgravity experiments conducted in the Japanese Experiment Module which will be attached to International Space Station Alpha in 2000. NASDA's experiments in MSL-1 are explained in this paper. (Author)

A96-32560 Japanese microgravity Spacelab experiments. M. MOHRI (NASDA, Tsukuba, Japan). *Strengthening cooperation in the 21st century; Proceedings of the 6th International Space Conference of Pacific Basin Societies*, Marina Del Rey, CA, 1995 (A96-32532 08-12), American Astronautical Society, San Diego, CA (Advances in Astronautical Sciences. Vol. 91), 1996, pp. 311–318 (AAS Paper 95-587). 10 Refs.

A review of Japanese microgravity experiments is presented. Three Spacelab-J mission material processing experiments, each using a different electric furnace, provided evidence that a microgravity environment is promising for the processing of semiconductors. Doped impurities were homogeneously distributed in a microgravity environment, which resulted in an increase of four orders of magnitude larger in conductivity than that grown on the ground. Extremely low etch pit density was discovered in a silicon-tin-telluride crystal, and grown in a free, containerless environment. A protective sleeve of oxide prevented Marangoni convection in an indium antimonide crystal using a floating zone method and resulted in an extremely large, high quality crystal. (Author)

A96-18554 Hydrostatic stability of concentric two-liquid columns. A. PRAKASH, F. OTSUBO, K. YASUDA, K. KUWAHARA, and T. DOI (NASDA, Tokyo, Japan). *AIAA 34th Aerospace Sciences Meeting and Exhibit*, Reno, NV, 1996, p. 11 (AIAA Paper 96-0594). 34 Refs.

A neutral buoyancy tank is developed for the experimental study of concentric two-liquid columns formed with immiscible liquids. The formation of a two-liquid column, or an encapsulated liquid bridge, in the new facility is described. The hydrostatic stability of two-liquid columns is also examined theoretically. (Author)

N96-15592 Diagnostics in Japan's microgravity experiments. T. KADOTA. *NASA Lewis Research Center, The 3rd International Microgravity Combustion Workshop*, pp. 257–262 (SEE N96-15552 03-29).

The achievement of the combustion research under microgravity depends substantially on the availability of diagnostic systems. The non-intrusive diagnostic systems are potentially applicable for providing the accurate, realistic and detailed information on momentum, mass and energy transport, complex gas phase chemistry, and phase change in the combustion field under microgravity. The non-intrusive nature of optical instruments is essential to the measurement of combustion process under microgravity which is very nervous to any perturbation. However, the implementation of the nonintrusive combustion diagnostic systems under microgravity is accompanied by several constraints. Usually, a very limited space is only available for constructing a highly sophisticated system which is so sensitive that it is easily affected by the magnitude of the gravitational force, vibration and heterogeneous field of temperature and density of the environments. The system should be properly adjusted prior to the experiment. Generally, it is quite difficult to tune the instruments during measurements. The programmed sequence of operation should also be provided. Extensive effort has been toward the development of nonintrusive diagnostic systems available for the combustion experiments under microgravity. This paper aims to describe the current art and the future strategy on the non-intrusive diagnostic systems potentially applicable to the combustion experiments under microgravity in Japan. (Author)

N96-15583 Research on ignition and flame spread of solid materials in Japan. K. ITO and O. K. FUJITA. *NASA Lewis Research Center, The 3rd International Microgravity Combustion Workshop*, pp. 201–206 (SEE N96-15552 03-29).

Fire safety is one of the main concerns for crewed missions such as the space station. Materials used in spacecraft may burn even if metalic. There are severe restrictions on the materials used in spacecraft from the view of fire safety. However, such restrictions or safety standards are usually determined based on experimental results under normal gravity, despite large differences between the phenomena under normal and microgravity. To evaluate the appropriateness of materials for use in space, large amount of microgravity fire-safety combustion data is urgently needed. Solid material combustion under microgravity, such as ignition and flame spread, is a relatively new research field in Japan. As the other reports in this workshop describe, most of microgravity combustion research in Japan is droplet combustion as well as some research on gas phase combustion. Since JAMIC, the Japan Microgravity Center (which offers 10 s microgravity time) opened in 1992, microgravity combustion research is robust, and many drop tests relating to solid combustion (paper combustion, cotton string combustion, metal combustion with Aluminium or Magnesium) have been performed. These tests proved that the 10 s of microgravity time at JAMIC is useful for solid combustion research. Some experiments were performed before JAMIC opened. For example, latticed paper was burned under microgravity by using a 50 m drop tower to simulate porous material combustion under microgravity. A 50 m tower provides only 2 s microgravity time however, and it was not long enough to investigate the solid combustion phenomena. (Author)

N96-15564 Japan's research on droplet and droplet array combustion. M. KONO. *NASA Lewis Research Center, The 3rd International Microgravity Combustion Workshop*, pp. 83–88 (SEE N96-15552 03-29).

In Japan, the ignition and combustion of the droplet and droplet array have been investigated by using microgravity condition. This is the short introduction of those studies; interactive combustion of two droplets, ignition experiment on droplet array, and microexplosion behavior of an emulsified fuel droplet. (Derived from text).

A96-10131 Gallium arsenide crystal growth from metallic solution under microgravity. Y. SUZUKI, S. KODAMA, and O. UEDA (Space Technology Corp., Atsugi, Japan) and O. OHTSUKI (Fujitsu Labs., Ltd., Atsugi, Japan). *Advances in Space Research* (ISSN 0273-1177), Vol. 16, No. 7, 1995, pp. 195–198. 6 Refs.

Homogeneous and low-defect crystals are important to improving semiconductor devices. This paper reports the properties of GaAs crystals grown from a metallic solution under microgravity. Growth was free from convection caused by surface tension and by gravity. Our experiment was performed aboard the Second German Spacelab Mission D-2. (Author)

A95-45064 Translation of an object using phase-controlled sound sources in acoustic levitation. T. MATSUI, E. OHDAIRA, N. MASUZAWA, and M. IDE (Musashi Inst. of Technology, Tokyo, Japan). *Japanese Journal of Applied Physics* (ISSN 0021-4922), Vol. 34, No. 5B, 1995, pp. 2771–2773. 9 Refs.

Acoustic levitation is used for positioning materials in the development of new materials in microgravity. This technique is applicable to materials for which electromagnetic force cannot be used. If the levitation point of the materials can be controlled freely in this application, possibilities of new applications will be extended. We report on an experimental study on controlling the levitation point of the object in an acoustic levitation system. The system has two sound sources with vibrating plates facing each other. Translation of the object can be achieved by controlling the phase of the energizing electrical signal for one of the sound sources. It was found that the levitation point can be moved smoothly in proportion to the phase difference between the vibrating plates. (Author)

A95-41160 Flow characteristics of gas-liquid two-phase flow under microgravity. T. FUJII, T. NAKAZAWA, H. ASANO, and H. YAMADA (Kobe Univ., Japan). *Proceedings of the 6th Asian Congress of Fluid Mechanics*, Singapore, 1995, Vol. 2 (A95-41024 11-34), Nanyang Technological Univ., Singapore, 1995, pp. 1110–1113. 2 Refs.

The present report deals with the flow characteristics of gas-liquid two-phase flow under microgravity, utilizing parabolic trajectory flights. The experiments were carried out on a horizontal transparent acrylic resin tube of 10.5 mm ID and 500 mm length, using GN2 and water as the working fluids, in a superficial gas velocity range of 0.025–4.5 m/s and a superficial water velocity range of 0.05–035 m/s. The flow pattern, pressure drop, and void fraction obtained in the microgravity experiments are compared with the results of the ground test, and also with the other experimental results. (Author)

A95-39343 Fabrication of uniform Al-Pb-Bi monotectic alloys under microgravity utilizing the Space Shuttle—Microstructure and superconducting properties. H. FUJII, T. KIMURA, H. KITAGUCHI, H. KUMAKURA, and K. TOGANO (National Research Inst. for Metals, Tsukuba, Japan) and M. MOHRI (NASDA, Tsukuba, Japan). *Journal of Materials Science* (ISSN 0022-2461), Vol. 30, No. 13, 1995, pp. 3429–3434. 7 Refs.

Al-Pb-Bi monotectic alloys with three different compositions were melted and solidified under a microgravity environment in the Space Shuttle. The (Pb, Bi) particles were dispersed uniformly in the aluminum matrix, while evident sedimentation was observed in the reference sample processed under 1 G. Slow cooling was also effective to obtain homogeneous microstructure because of the absence of Marangoni force. The alloys were cold-worked into wires, and the superconducting properties of the wires were investigated. The distance between (Pb, Bi) fibers for the alloys prepared under microgravity was so small that the wires showed complete zero resistance below 9 K due to the proximity effect. (Author)

A95-34905 Thermally driven flow experiments aboard Space Shuttle. M. FURUKAWA (NASDA, Tsukuba Space Center, Japan) and Y. MIYAZAKI and T. YAMAZAKI (Toshiba Corp., Komukai Works, Kanagawa, Japan). *AIAA 30th Thermophysics Conference*, San Diego, CA, 1995, p. 9 (AIAA Paper 95-2069). 9 Refs.

Details of thermally driven flow experiments, performed last July as a mission of IML2 (Second International Microgravity Laboratory), are reported mainly from an engineering viewpoint. Described in this connection is a thermal accumulator model, named TDFU (Thermally Driven Flow Unit). A way of liquid transfer in TDFU is depicted in the figure for comprehension of operational principles. Hardware design specifications, the process of experiments, and imposed vibrational conditions are stated and then are summarized in the tables. Photographs including some critical scenes are presented to demonstrate that liquid/vapor phase separation, liquid positioning, and liquid transfer were satisfactorily done in TDFU aboard the Space Shuttle. Experimental results show that the observed liquid travel distance was such as theoretically estimated and that the measured vessel temperatures were similar to predicted ones. A conclusion of technical importance is thus drawn that thermally driven flows are instrumental in fluid management under microgravity. (Author)

A95-26161 Spray cooling characteristics under reduced gravity. M. KATO (Keio Univ., Yokohama, Japan); Y. ABE (Electrotechnical Lab., Tsukuba, Japan); and Y. MORI and A. NAGASHIMA (Keio Univ., Yokohama, Japan). *Journal of Thermophysics and Heat Transfer* (ISSN 0887-8722), Vol. 9, No. 2, 1995, pp. 378–381. 3 Refs. Documents available from AIAA Dispatch.

Results are presented of experiments on spray cooling under reduced gravity conditions which were conducted on the basis of parabolic flights on an aircraft. Terrestrial reference experiments for horizontal upward and vertical heater orientations showed a noticeable effect of heater orientation, especially in the transition region. A reduction in gravity yielded a reduction in the critical heat flux (CHF) for the liquid CFC-113, but an increase in the CHR for water. Both liquids showed a heat transfer enhancement in the low heat flux region below the CHF by the reduction in gravity.

A95-19944 Gas evaporation in space (low-gravity ultrafine-particle production by materials evaporation in inert gas). N. WADA and M. KATO (Nagoya Univ., Japan); M. DOHI (Shizuoka Inst. of Science and Technology, Toyosawa, Japan); S. SAWAI and M. TANI (Nagoya Univ., Japan); M. SENGOKU (Aichi Medical Univ., Japan); and T. GOTOH, T. SATO, and T. NODA (Nagoya Univ., Japan). *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 33, No. 12, 1994, pp. 6648–6653. 11 Refs.

Silver (Ag) was evaporated in argon (Ar) and xenon (Xe) gases at various pressures in the low-gravity environment aboard the Space Shuttle. Four glass bulbs with filament tips coated with 50 mg of Ag were filled with Ar gas of 6.7 Pa (A) or 40 Pa (B) or Xe gas of 0.67 Pa (C) or 1.33 Pa (D) and ignited one by one in the low gravitational field of space. The evaporation temperatures were maintained at 1150 C, at which smoke plumes were barely detectable in all cases in the ground experiment. A ball of smoke particles appeared to grow around the evaporation source instead of rising as it would under Earth gravity conditions. No smoke was observed in (A), but it was observed in (B) and (C), and bursts of smoke extended in various directions from the smoke ball in the case of (D). The experiment suggested that vapor could be confined locally around the source with high pressure and temperature by the surrounding gas

in low gravity. This suggestion cannot be derived from any conventional model of evaporation in the gas. (Author)

A95-16461 Synthesis of SiC fine particles by gas-phase reaction under short-time microgravity. T. OKUTANI, Y. NAKATA, M. SUZUKI, and Y. MANIETTE (Government Industrial Development Lab., Sapporo, Japan); N. GOTO (Hoxan Corp., Sapporo, Japan); and O. ODAWARA and K. MORI (Tokyo Inst. of Technology, Yokohama, Japan). *Nanophase and nanocomposite materials* (A95-16451 03-23), Materials Research Society, Pittsburgh, PA (MRS Symposium Proceedings. Vol. 286), 1993, pp. 113–118. 5 Refs.

SiC fine particles were synthesized by the gas-phase thermal decomposition of tetramethylsilane ($Si(CH_3)_4$) in hydrogen under microgravity of 10 exp -4 *g* for 10 s. Rapid heating to the temperature over 800°C which is required for thermal decomposition of $Si(CH_3)_4$ under short-time microgravity was attained using a chemical oven where the heat of the exothermic reaction of combustion synthesis of Ti-Al-4B composites was used as the heat source. Monodisperse and spherical SiC fine particles were synthesized under microgravity, whereas aggregates of SiC fine particles were synthesized under 1*g* gravity. The SiC particles synthesized under microgravity (150–200 nm) were bigger in size and narrower in size distribution than those under 1*g* gravity (100–150 nm). (Author)

A95-12723 On the levitation of a liquid drop in 1-g field. H. KAMIMURA, S. YOSHIHARA, and H. AZUMA (National Aerospace Lab., Chofu, Japan). *Proceedings of the 18th International Symposium on Space Technology and Science*, Kagoshima, Japan, 1992, Vol. 2 (A95-12376 01-12), AGNE Publishing, Inc.,Tokyo, Japan, 1992, pp. 2335–2339. 5 Refs.

For most drop experiments, a microgravity environment is essentially required, because a drop cannot be kept in the same spot in a gravity field. However, a true microgravity environment is available only in an orbiter such as the Space Shuttle, with a preparation time far longer than that of usual ground-based experiments. Drop towers and parabolic aircraft flights are useful in making up for scarce experimental opportunities. But these still require a long turn-around time and lack experimental flexibility. If a mechanism is available which is capable of levitating a liquid drop in the presence of gravity, drop experiments will be easy to conduct. We have developed an acoustic drop levitator which is driven in a dense ambient gas, in order to improve the efficiency in transmitting vibrating energy from the sound source. Consequently, an oil drop can be levitated in an acoustic enclosure, although the drop is for now greatly deformed by high acoustic pressure. (Author)

A95-12721 Preliminary experiments on gas plasma and diamond deposition by Gas Dynamics Experiment Facility. Y. SATO and T. ANDO (National Inst. for Research in Inorganic Materials, Tsukuba, Japan); T. INUZUKA (Aoyama Gakuin Univ., Tokyo, Japan); N. FUJIMORI and N. OTA (Sumitomo Electric Industries, Hyogo, Japan); M. ISHIKAWA, S. KAMEI, and T. HANYUU (Mitsubishi Research Inst., Tokyo, Japan); K. SHIBUKAWA and K. MURAKAMI (NASDA, Tokyo, Japan); et al. *Proceedings of the 18th International Symposium on Space Technology and Science*, Kagoshima, Japan, 1992, Vol. 2 (A95-12376 01-12), AGNE Publishing, Inc., Tokyo, Japan, 1992, pp. 2323–2328. 4 Refs.

A study on the fundamental factors which affect plasma-assisted vapor deposition of diamond performed under microgravity conditions has been made under 1 *g* and 0.01 *g* conditions. Plasma reactor design has been refined through diamond deposition experiments on the ground. Experiments utilizing parabolic flights have shown that thermal flow behavior at 20–100 Torr agrees with theoretical predictions. Gravitational effects on plasma stability, emission and substrate temperature have been also studied. (Author)

A95-12718 Experimental investigation of composite channel heat pipe operation in micro-gravity environment. T. OGUSHI and M. MURAKAMI (Mitsubishi Central Research Lab., Amagasaki, Japan); M. KITADA and A. YAO (Mitsubishi Electric Corp., Kamakura Works, Japan); and M. KAWAJI (Toronto Univ., Canada). *Proceedings of the 18th International Symposium on Space Technology and Science,* Kagoshima, Japan, 1992, Vol. 2 (A95-12376 01-12), AGNE Publishing, Inc., Tokyo, Japan, 1992, pp. 2303–2307. 2 Refs.

This paper describes an experimental investigation of heat transfer performance and liquid flow in composite channel heat pipe under microgravity conditions. To verify the normal liquid flow in the channel under micro-gravity, the liquid flow behavior was investigated by using a visualization model. The temperature drop in the thermal model of the heat pipe was measured under both micro-gravity and normal gravity to verify the effectiveness of the channel operation under micro-gravity. Methanol was selected as the working fluid. From the experiment performed aboard a KC-135 aircraft, it was found that a liquid puddle was generated at the bottom of the pipe under normal and hyper-gravity, but the liquid spread out to the top of the pipe through the axial and double ring channels under reduced gravity. The temperature drop in the heat pipe was also found to decrease when gravity changed to 0.01*g*, which verified the normal operation of the composite channels in the heat pipe under micro-gravity conditions. (Author)

A95-12715 Experimental investigation of flow-boiling heat transfer under microgravity. R. K. LUI and M. KAWAJI (Toronto Univ., Canada) and T. OGUSHI (Mitsubishi Central Research Lab., Amagasaki, Japan). *Proceedings of the 18th International Symposium on Space Technology and Science,* Kagoshima, Japan, 1992, Vol. 2 (A95-12376 01-12), AGNE Publishing, Inc., Tokyo, Japan, 1992, pp. 2283–2288. 11 Refs.

An experimental apparatus has been constructed and used to investigate one-component flow-boiling heat transfer under microgravity conditions. Freon-113 was injected at a constant rate into a cylindrical stainless steel test section. The horizontal test section was heated externally up to 30 kW/sq m by a flexible strip heater. The subcooled freon was boiled within the length of the test section to produce two-phase flow. Thermocouples attached to the outer surface of the test section measured the steady tube wall temperature profiles. The resulting two-phase flow was then condensed and cooled before being recirculated in the flow loop. Experiments under microgravity were performed aboard the KC-135 aircraft. Preliminary tests have indicated satisfactory operation of the experimental apparatus. (Author)

A95-12713 Solutal diffusion measurement for liquid Pb(1 − x)Sn(x)Te under microgravity—TEXUS 26 rocket experiment. M. UCHIDA, M. KANEKO, and T. HORITOMI (Space Technology Corp., Tokyo, Japan) and Y. NAKAGAWA (Ishikawajima–Harima Heavy Industries Co., Ltd., Tokyo, Japan). *Proceedings of the 18th International Symposium on Space Technology and Science*, Kagoshima, Japan, 1992, Vol. 2 (A95-12376 01-12), AGNE Publishing, Inc., Tokyo, Japan, 1992, pp. 2271–2276. 6 Refs. Documents available from AIAA Dispatch.

A microgravity experiment using the TEXUS rocket, which included a 1-*g* reference test with the same module, and ground experiments, was performed in order to obtain the 'true' diffusion coefficient of liquid PbSnTe. A 2-mm-diameter capillary was found to provide nonconvection conditions sufficiently close to those in the flight experiments to date. It is concluded that the diffusion coefficient in a successful microgravity experiment should be equal or lower than the value on the ground experiment. High solidification rates avoiding axial directional solidification are preferred.

A95-12711 Melting and solidification of YBaCuO ceramics in microgravity. H. KITAGUCHI and K. TOGANO (National Research Inst. for Metals, Tsukuba, Japan); S.-I. YODA (NASDA, Tokyo, Japan); T. MACHIDA (NEC Corp., Yokohama, Japan); and H. NISHIMURA (Nichiden Machinery, Ltd., Kusatsu, Japan). *Proceedings of the 18th International Symposium on Space Technology and Science*, Kagoshima, Japan, 1992, Vol. 2 (A95-12376 01-12), AGNE Publishing, Inc., Tokyo, Japan, 1992, pp. 2259–2263. 4 Refs.

Melting and solidification of polycrystalline $YBa_2Cu_3O_x$ bulk sample in microgravity was studied. One objective of this study is to attain uniform dispersion of Y_2BaCuO_5 particles, which is expected to act as the pinning center of magnetic flux and to enhance the Jc value. The other objective is to improve the fundamental understanding of melting and solidification phenomena in microgravity. A microgravity experiment with the TR1A sounding rocket was carried out along with a ground experiment. (Author)

A95-12710 Microstructure of dispersion alloys solidified in microgravity. Y. MURAMATSU, K. HARADA, and T. DAN (National Research Inst. for Metals, Tokyo, Japan); S. YODA (NASDA, Tokyo, Japan); and S.-I. ANZAWA (Ishikawajima–Harima Heavy Industries Co., Ltd., Tokyo, Japan). *Proceedings of the 18th International Symposium on Space Technology and Science*, Kagoshima, Japan, 1992, Vol. 2 (A95-12376 01-12), AGNE Publishing, Inc., Tokyo, Japan, 1992, pp. 2255–2258. 2 Refs.

Two different dispersion alloys, Cu-5 vol% Al_2O_3 and Cu-5 vol% W, were melted and solidified in microgravity. Their microstructures were examined by a microscope and SEM in comparing with those of the dispersion alloys melted and solidified on the ground. The experimental results showed that the morphology of solidified microstructures was influenced by gravity, particle size, and interfacial energies of molten copper and solid Al_2O_3 or tungsten. It was concluded that melting and solidification under microgravity was favorable for a uniform dispersion, and the segregation of dispersoids in the terrestrial experiment was mainly due to bubble motion, thermal convection, and different densities of components. (Author)

A95-12709 Marangoni convection in a liquid column under microgravity—Experiment using a TR-1A sounding rocket and computer simulations. M. OHNISHI, S. YOSHIHARA, and H. AZUMA (National Aerospace Lab., Chofu, Japan); S. YODA (NASDA, Tokyo, Japan); and K. KAWASAKI (Nissan Motor Co., Ltd., Tokyo, Japan). *Proceedings of the 18th International Symposium on Space Technology and Science*, Kagoshima, Japan, 1992, Vol. 2 (A95-12376 01-12), AGNE Publishing, Inc., Tokyo, Japan, 1992, pp. 2247–2253. 3 Refs.

An experiment on Marangoni convection in a liquid column of silicone oil under microgravity was performed using the TR-1A sounding rocket and compared with computer simulations. During the experiment, time-dependent cross-sectional distributions of aluminum particles in the column were observed using FTX (Fluid dynamics Technology experiment equipment). By tracing the paths of the particles, time-dependent and quasi-steady velocity profiles of Marangoni convection were obtained. Experimental results agree with simulated results, demonstrating sufficient experimental resolution. (Author)

French Aerospace Literature
This month: *Microgravity Experiments*

A97-17401 In situ and real-time observation by optical methods of cellular directional solidification of a transparent alloy in a cylinder. N. NOEL, H. JAMGOTCHIAN, and B. BILLIA (Aix-Marseille III Univ., Marseille, France). *Proceedings of the ESA Space Station Utilisation Symposium*, Darmstadt, Germany, 1996 (A97-17345 03-12), European Space Agency, Noordwijk, Netherlands, 1996, pp. 321–324. 11 Refs.

By implementing optical diagnostics on a Bridgman setup, in situ and real-time observation of the morphology of solid-liquid interface during upward growth of a succinonitrile-acetone alloy in a cylinder was carried out. Observation under white light in the solidification direction yielded bright field images of the interface microstructure. Video records allowed the following of the birth of morphological instability and development of cells. The influence of grain boundaries was analyzed. On Earth, fluid flow in the liquid phase, revealed by the advection of foreign particles, was unavoidable. It affected the onset of nonplanar growth and the dynamics of pattern formation. It is now necessary to develop systematic studies and, in particular, to determine how and to which extent cellular arrays, and beyond dendrites, are influenced by convection. Reference micro-*g* experiments that would provide critical information are planned. (Author)

A97-17389 The role of gravity forces on interfacial reactions—Electrodeposition of metals. F. ARGOUL, G. GADRET, C. LEGER, and F. TEXIER (Centre de Recherche Paul Pascal, Pessac, France). *Proceedings of the ESA Space Station Utilisation Symposium*, Darmstadt, Germany, 1996 (A97-17345 03-12), European Space Agency, Noordwijk, Netherlands, 1996, pp. 259–264. 32 Refs.

We discuss the implication of gravity forces for an interfacial reaction process and their influence on the temporal dynamics when transport processes are limiting the reaction kinetics. In particular, the role of buoyancy forces is illustrated in electrodeposition and cementation experiments in thin gap cells, where the morphology of the crystal grown by electrochemical reduction of a metal cation provides a direct visualization of the interfacial dynamics. (Author)

A97-17388 Influence of interface anisotropy on microstructure selection in directionally solidified binary alloys. H. N. THI and B. BILLIA (Aix-Marseille III Univ., Marseille, France). *Proceedings of the ESA Space Station Utilisation Symposium*, Darmstadt, Germany, 1996 (A97-17345 03-12), European Space Agency, Noordwijk, Netherlands, 1996, pp. 253–257. 19 Refs.

Significant theoretical studies, carried out during the last decade, have shown that anisotropic properties of the interface play a crucial role in the selection of microstructure. Directional solidification provides a unique opportunity to study the effect of anisotropy since experimental conditions can be controlled precisely. Thus, new research should be carried out with the aim of developing a long range, coherent, systematic, and definitive study of the influence of interface anisotropy on microstructure formation. The study of planar interface instability and the development of cellular pattern through the selection of wavelength and orientation provides ideal conditions to analyze the role of anisotropy. One of the critical problems is that the conditions under which cellular structures are stable are precisely the ones where gravitationally induced fluid flow becomes dominant. The precise understanding of anisotropic effects thus requires critical experiments in bulk samples in a microgravity environment. (Author)

A96-44756 New insight on the solidification of Al-In monotectic alloy. B. VINET and J. J. FAVIER (CEA, Centre d'Etudes Nucleaires de Grenoble, France). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 271–276. 17 Refs.

A decade ago we reported the results on solidification of Al-In monotectic alloys carried out by the horizontal Bridgman's method. By means of this configuration, regular structures of fibers or globules were obtained in massive samples. This work originated from experiments performed in a centrifuge up to 70 g. In this contribution, we describe the microstructures observed for these very unusual solidification conditions. The effect produced by the natural convection in the growth of regular monotectic is examined. Particular attention is also paid to some transient microstructures. (Author)

A96-43963 MEPHISTO/USMP-3/STS 75—Preliminary results. G. GAMBON and G. HIEU (CNES, Toulouse, France); J. J. FAVIER, J. P. GARANDET, B. DREVET, J. E. MAZILLE, E. ROLLAND, F. HERBILLON, and N. KERNEVEZ (CEA, Centre d'Etude et de Recherche sur les Materiaux, Grenoble, France); and J. I. D. ALEXANDER (Alabama Univ., Huntsville). *IAF 47th International Astronautical Congress*, Beijing, China, 1996, p. 9 (IAF Paper 96-J303). 5 Refs.

The MEPHISTO experiment was flown for the third time from February 22nd to March 8th, 1996 on the NASA STS-75/USMP-3 mission. The scientific program conducted during this time was oriented on the behavior of the growth of metallic alloys with higher concentration than it was the case for the first flight. Scientific and technical results confirmed the successful behavior of the experiment under microgravity conditions, and the sensitivity of the experiments to microgravity disturbances (*g*-jitters) was successfully monitored thanks to the 'Seebeck' diagnostics, among others, that are described in this paper. The preliminary results obtained during the mission show how the controlled microgravity disturbances generated by the space shuttle Columbia have affected the material sample growth and also give an indication of what could be expected for the next experiments on board the Space Station. These data were obtained in real time during the mission and are the results of the ground-based team interactivity with the experimental processing in space, in conjunction with the Shuttle pilot. This work was supported with real-time computations of the simulated experiment behavior. (Author)

A96-43413 Wetting of InSb melts on crucibles in weightlessness—Results of the TEXUS 32/TEM 01-4 experiment. T. DUFFAR and J. ABADIE (CEREM, Grenoble, France). *Microgravity—Science and Technology* (ISSN 0938-0108), Vol. 9, No. 1, 1996, pp. 35–39. 10 Refs.

The aim of the TEXUS 32/TEM 01-4 experiment was to investigate the wetting behavior of InSb melts on silica, BN, and carbon smooth or rough crucibles. After a description of the experimental cartridge, thermal profile, and procedure, the results are discussed. It is found that the shape of the solid material after processing is governed not only by the crucible shape but by faceting effects in the case of polycrystalline material. It is also shown that the liquid was situated, during flight, in the middle of the crucible, with no contact with the crucible ends. This result is explained on the basis of a high contact angle between the melt and the crucible, due to slight oxygen contamination of the sample. (Author)

A96-36883 High pressure droplet burning experiments in reduced gravity. C. CHAUVEAU, B. VIEILLE, and I. GOKALP (CNRS Lab. de Combustion et Systemes Reactifs, Orleans, France). *AIAA, ASME, SAE, and ASEE 32nd Joint Propulsion Conference and Exhibit*, Lake Buena Vista, FL, 1996, p. 8 (AIAA Paper 96-2627). 22 Refs.

High pressure droplet burning characteristics of five fuels are investigated under normal and reduced gravity conditions. The reduced gravity experiments were conducted by using the parabolic flights of the CNES Caravelle and the NASA KC-135 aircraft. A fully automatic high pressure droplet gasification facility was developed for these experiments. High speed camera is used to determine the time histories of burning droplets, from which average droplet burning rates are determined. For all experiments, the suspended droplet technique is used. Initial droplet diameters are about 1.5 mm. Subcritical and supercritical droplet burning regimes are explored. The experimental results for all fuels show that the droplet burning lifetime decreases strongly with increasing pressure in the subcritical regime. When the pressure is increased above the critical pressure of the pure liquid, the droplet burning lifetimes remain constant in the average. (Author)

A96-34706 High pressure droplet burning experiments in reduced gravity. C. CHAUVEAU, X. CHESNEAU, B. VIEILLE, A. ODEIDE, and I. GOEKALP (CNRS Lab. de Combustion et Systemes Reactifs, Orleans, France). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin (Lecture Notes in Physics. Vol. 464), 1996, pp. 415–424. 22 Refs.

The paper summarizes research on high pressure burning of single fuel droplets and describes recent results obtained under normal and reduced gravity conditions with suspended droplets. Parabolic flights were used to create a reduced gravity environment. Droplet burning experiments using methanol, *n*-heptane, *n*-hexane, and *n*-octane were performed at ambient air temperature and pressures in the range of 0.1–12 MPa. The combination of high pressure droplet burning experiments with reduced gravity is crucial in order to reduce the pressure enhanced natural convection effects and also to extend the applicability of the fiber suspended droplet technique when the surface tension decreases due to the closeness of thermodynamic critical conditions. The experimental results presented in this paper show a decrease of the droplet burning time with pressure in the subcritical domain. The minimum burning time observed by other investigators around the critical pressure was not found in this study for the four fuels investigated. This may be attributed to the pressure enhanced natural convection effects due to the residual gravity during parabolic flight experiments. (Author)

A96-34705 Flat plate diffusion flames—Numerical simulation and experimental validation for different gravity levels. J. L. TORERO, H.-Y. WANG, P. JOULAIN, and J. M. MOST (Poitiers Univ., Futuroscope, France). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin (Lecture Notes in Physics. Vol. 464), 1996, pp. 401–413. 19 Refs.

A laminar diffusion flame is established over a horizontal flat plate burner when ethane is injected into a stream of air flowing parallel to the burner. A three dimensional stationary numerical solution is obtained for the temperature and velocity fields with the aim of better understanding the effect of buoyancy. The chemical reaction is described by the flame sheet approximation; therefore, fuel, oxidizer, inert gases and products are assumed to go through a single global reaction step with an infinitely fast reaction rate. The results obtained from the numerical simulation are compared with experiments conducted under different gravity levels. The parameters studied are velocity and temperature profiles as well as the flame geometry. The numerical simulation describes very well the geometry of the flame in the presence of gravity; in its absence, the stationary model is accurate only close to the leading edge. As the distance from the leading edge increases the numerical solution underpredicts the stand-off distance. (Author)

A96-34692 The effect of natural convection on the measurement of mass transport coefficients in the liquid state. J. P. GARANDET, C. BARAT, J. P. PRAIZEY, and T. DUFFAR (CEA, Centre d'Etudes Nucleaires de Grenoble, France) and S. V. VAERENBERGH (Bruxelles Univ. Libre, Brussels, Belgium). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin (Lecture Notes in Physics. Vol. 464), 1996, pp. 253–259. 5 Refs.

This paper focuses on the effect of natural convection on the accuracy of solute diffusion coefficient measurements in liquid alloys in microgravity. We consider the cases of both isothermal diffusion and thermodiffusion (Soret effect). Numerical simulations indicate that the error induced by additional convective transport scales with the square of the fluid velocity. Our main conclusion is that it is in principle possible to perform accurate measurements in space, but that the size of the capillaries used in the experiments should always be limited, especially in the case of highly concentrated alloys. (Author)

A96-34682 A study of morphological stability during directional solidification of a Sn-Bi alloy in microgravity. J. J. FAVIER, P. LEHMANN, B. DREVET, J. P. GARANDET, and D. CAMEL (CEA, Grenoble, France) and S. R. CORIELL (NIST, Gaithersburg, MD). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin (Lecture Notes in Physics. Vol. 464), 1996, pp. 77–94. 15 Refs.

The morphological stability of the solid-liquid interface in Sn-0.58 at.% Bi alloys was studied during the first MEPHISTO space experiment. The transition from a planar front to a destabilized front is investigated through the in-situ measurement of the Seebeck voltage between the ends of a directionally solidified sample. This technique makes it possible to precisely detect the instability threshold in steady state conditions as well as during transient stages. Wavelengths and segregation patterns of microstructures corresponding to well-defined distances to threshold are characterized by post mortem analyses. The experimental results are discussed within the frame of the Mullins and Sekerka's theory and three-dimensional nonlinear calculations. (Author)

A96-34678 Numerical solutions of thermoacoustic and buoyancy-driven transport in a near critical fluid. B. ZAPPOLI and P. CARLES (CNES, Toulouse, France); S. AMIROUDINE (Marseille, Inst. de Mecanique des Fluides, France); and J. OUAZZANI (Arcofluid, Marseille, France). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin (Lecture Notes in Physics. Vol. 464), 1996, pp. 27–40. 24 Refs.

This paper presents the mechanisms of heat and mass transport of one- and two-dimensional low Mach number, unsteady, viscous, low heat diffusing, hypercompressible Navier–Stokes equations of a van der Waals gas (CO_2). The results focus on some striking behaviors compared to those obtained for normally compressible gases: 1) heat equilibration is still achieved very fast under normal gravity conditions, as under zero-*g* conditions, by the Piston Effect before buoyancy convection has time to enhance heat transport; 2) mass equilibration is achieved on a much longer time scale by a quasi-isothermal buoyant convection; 3) due to the very high compressibility, a stagnation point effect as that encountered in high speed flows provokes an overheating of the upper wall of a heated square cavity; and 4) a significant difference with the convective single roll pattern generated under the same condition in normal CO_2 is also found: on the Piston Effect time scale, under the form of a Marangoni-like pattern due to the very thin boundary layer-localized density gradients; on the heat diffusion time scale under the form of a double roll convective structure. (Author)

A96-24231 Nonsteady boiling in microgravity. K. SEFIANE and A. STEINCHEN (Aix-Marseille III Univ., Marseille, France). *Microgravity Science and Technology* (ISSN 0938-0108), Vol. 8, No. 3, 1995, pp. 180–187. 16 Refs.

The present paper aims to model the existing peak of heat transfer coefficient due to the existence of transient nucleate boiling, under low-gravity conditions. Transient nucleate boiling under microgravity has been observed in drop tower experiments. At the level of low gravity obtained, the conduction heat flux in the thermal boundary layer and in the microlayers in the liquid close to the heating surface and around the bubbles, the evaporation and condensation fluxes, the heat flux due to Marangoni convection around the bubbles, and the flux associated with the vapor recoil effect around the growing bubbles are the only fluxes contributing significantly to the global heat transfer. To predict the total heat flux resulting from all these contributions, a knowledge of the dynamics of the covering of the heating surface by bubbles is required. The model includes a statistical law giving the time evolution of the surface covered by bubbles. This original method allows the authors to predict the coalescence time of the bubbles. This time corresponds to the end of transient nucleate boiling. Beyond this point, the heat transfer coefficient abruptly drops due to the formation of a continuous heat resistant vapor film on the heater. (Author)

A96-18100 Recent developments of the European microgravity activities in physical sciences. Y. MALMEJAC (CEA, Grenoble, France) and H. U. WALTER (ESA, Paris, France). *AIAA 34th Aerospace Sciences Meeting and Exhibit*, Reno, NV, 1996, p. 8 (AIAA Paper 96-0129).

A summary of ESA's Microgravity Research Program in Physical Sciences is presented, including past, present, and future flight opportunities as well as the flight experiment facilities presently available and under development. Recommendations on research priorities by ESA's Microgravity Advisory Committee are summarized. The European Low-Gravity Research Association (ELGRA) has organized a further evaluation by peers of the highest international standing. The results of this evaluation are also presented. (Author)

A96-16310 Study of the continuous flow electrophoresis process—A sounding rocket program. H. ROUX-DE BALMANN and V. SANCHEZ (CNRS, Lab. de Genie Chimique et Electrochimie, Toulouse, France) and F. J. CHANGEART (CNES, Toulouse, France). *Proceedings of the ESA 12th Symposium on European Rocket and Balloon Programmes and Related Research*, Lillehammer, Norway, 1995 (A96-16286 03-12), European Space Agency, Noordwijk, Netherlands, 1995, pp. 155–159. 8 Refs.

In continuous flow electrophoresis, a purification process, separation is achieved in a flowing liquid film using an electric field via the difference between the electrophoretic mobilities of the components. Different transport phenomena take place, the coupling of which determines the efficiency of the separation. Microgravity offers the opportunity to improve knowledge of the process as well as to improve its efficiency. Two experiments were flown on TEXUS sounding rockets. Operating conditions were selected so as to favor electrohydrodynamic (EHD) phenomena. A highly concentrated sample not operable on ground because of convection was processed. The results were found to be very different from those predicted by extrapolating the ones obtained on ground for more dilute samples. Further research on ground showed that this apparent disagreement could be overcome by considering into more details the sample electrical properties while calculating the contribution of EHD. The model previously developed was extended to account for the appropriate parameter. (Author)

A96-15983 Undercooling experiments on the Re-rich part of the Re-W system by processing in a 48 m high drop-tube. B. VINET and S. TOURNIER (CEA, Centre d'Etudes Nucleaires de Grenoble, France) and P. J. DESRE (Grenoble, Inst. National Polytechnique, St.-Martin-d'Heres, France). *Materials Science Forum* (ISSN 0255-5476), Vols. 179–181, 1995, pp. 723–727. 12 Refs.

Over the hypoeutectic domain of the Re-W system (less than 25 at.% W), a hypercooling regime is reached. The temperature rise during recalescence passes through a minimum at about 14 at.% W, while the droplet aspect changes markedly. A decrease of the heat of crystallization is suggested. X-ray diffraction patterns of some as-quenched 14 at.% W droplets in solid tin indicate the unexpected presence of the W phase, together with the Re, sigma, and chi phases. This result opens the possibility for a metastable eutectic in this system. (Author)

N96-15587 On the effect of pressure, oxygen concentration, air flow and gravity on simulated pool fires. J. L. TORERO, J. M. MOST, and P. JOULAIN. *NASA Lewis Research Center, The 3rd International Microgravity Combustion Workshop*, pp. 227–232 (SEE N96-15552 03-29).

The initial development of a fire is characterized by the establishment of a diffusion flame over the surface of the condensed fuel and is particularly influenced by gravity, with most of the gaseous flow induced by natural convection. Low initial momentum of the fuel vapor, strong buoyant flows induced by the hot post-combustion gases and consequently low values of the Froude number (inertia-gravity forces ratio) are typical of this kind of scenario. An experimental study is conducted by using a porous burner to simulate the burning of a horizontal combustible surface. Ethane is used as fuel and different mixtures of oxygen and nitrogen as oxidizer. The magnitude of the fuel injection velocities is restricted to values that will keep the Froude number on the order of 10^{-5}, when calculated at normal gravity and pressure, which are characteristic of condensed fuel burning. Two different burners are used, a circular burner (62 mm diam) placed inside a cylindrical chamber (0.3 m diam and 1.0 m height) and a rectangular burner (50 mm wide × 200 mm long) placed in a wind tunnel (350 mm long) of rectangular cross section (120 mm wide and 90 mm height). The first burner is used to study the effect of pressure and gravity in the absence of a forced flow parallel to the surface. The second burner is used to study the effect of a forced flow parallel to the burner surface as well as the effect of oxygen concentration in the oxidizer flow. In this case experiments are also conducted at different gravity levels [micro-gravity, 0.2 *g* (sub 0), *g* (sub 0), and 1.8 *g* (sub 0)] to quantify the relative importance of buoyancy. (Author)

N96-15562 High pressure droplet burning experiments in reduced gravity. C. CHAUVEAU and I. GOEKALP. *NASA Lewis Research Center, The 3rd International Microgravity Combustion Workshop*, pp. 71–76 (SEE N96-15552 03-29).

A parametric investigation of single droplet gasification regimes is helpful in providing the necessary physical ideas for sub-grid models used in spray combustion numerical prediction codes. A research program has been initiated at the LCSR to explore the vaporization regimes of single and interacting hydrocarbon and liquid oxygen droplets under high pressure conditions. This paper summarizes the status of the LCSR program on the high pressure burning of single fuel droplets; recent results obtained under normal and reduced gravity conditions with suspended droplets are presented. In the work described here, parabolic flights of the CNES Caravelle is used to create a reduced gravity environment of the order of 10 (exp −2) *g* (sub 0). For all the droplet burning experiments reported here, the suspended droplet initial diameters are scattered around 1.5 mm; and the ambient air temperature is 300 K. The ambient pressure is varied between 0.1 and 12 MPa. Four fuels are investigated: methanol (Pc = 7.9 MPa), *n*-heptane (Pc = 2.74 MPa), *n*-hexane (Pc = 3.01 MPa), and *n*-octane (Pc = 2.48 MPa). (Derived from text).

A96-11380 Bridgman solidification of GaSb results of the EURECA AMF-118 experiment. T. DUFFAR, P. DUSSERRE, and M. D. SERRANO

(CEA, Centre d'Etudes Nucleaires de Grenoble, France). *Advances in Space Research* (ISSN 0273-1177), Vol. 16, No. 8, 1995, pp. 101–104. 4 Refs. Documents available from AIAA Dispatch.

Results of the EURECA AMF-118 experiment, which investigated chemical segregation during solidification during the growth of pure GaSb crystals and Ga(0.99)In(0.01)Sb crystals on Earth and under microgravity conditions, are discussed. The results show that the dewetting theory of semiconductor growth under microgravity conditions can explain the experimental observation that full dewetting occurs when roughness is sharp, enhancing crystal quality. A slight oxidation seems to help the process. It is reproducibly shown, for the first time in the case of GaSb, that a single crystal can be obtained from a polycrystal. Microgravity seems to decrease the effect of natural convection on chemical segregation of In.

A96-10494 SESAME—An up-to-date space furnace of the future Space Station. G. CAMBON, R. CAPRARO, and S. LEON-HIRTZ (CNES, Dept. Fluides et Materiaux, Toulouse, France) and D. CAMEL, J. P. GARANDET, T. DUFFAR, and J. J. FAVIER (CEA, Centre d'Etudes et de Recherche sur les Materiaux, Grenoble, France). *IAF 46th International Astronautical Congress*, Oslo, Norway, 1995, p. 7 (IAF Paper 95-J507).

SESAME is an acronym for the future French space furnace dedicated to materials science in microgravity on board the next International Space Station. This furnace system concept is based on the knowledge gained by the CNES on previous programs using various furnaces during several Spacelab and USMP missions. The SESAME System (System for Elaborating Semi-conductors and metallic Alloys in Microgravity Environment) is studied in order to accommodate various experiments and its performances are defined in order to satisfy most of scientific requirements. In-situ diagnostics with real-time analysis on ground and teleoperations capabilities will constitute one of the main interest of such a multiusers facility. (Author)

A96-10490 Survey of optical diagnosis dedicated to fluid physics and materials science. F. GONZALEZ and C. FAURE (CNES, Toulouse, France) and F. LEFAUCHEUX (Paris IV Univ., France). *IAF 46th International Astronautical Congress*, Oslo, Norway, 1995, p. 9 (IAF Paper 95-J502).

The evolution of scientific requirements to improve knowledge and understanding of sophisticated phenomena occurring during microgravity experiences leads to implement new generation of hardware with more than classical instrumentation such as temperature or pressure measurement; optical diagnosis for in-situ characterization is the unavoidable answer to this problem. This paper deals with a survey, performed by CNES, for identifying each unique optical system with respect to each optical diagnosis selected to satisfy experimental scenarios in crystal growth, directional solidification, fluid physics, and physical chemistry. The survey points out the need for high resolution video data links and 'real time holography'. A new generation of advanced technology derives from this study, especially the use of photorefractive crystals and polymer resins for hologram recordings. Such optical diagnosis will be implemented in a new multiuser facility (CHEOPS) developed by CNES for the next Columbus Orbital Facility. (Author)

A96-10461 MEPHISTO—Overview of recent flight results obtained from diagnostics technique (space materials processing). G. CAMBON and G. HIEU (CNES, Toulouse, France) and J. J. FAVIER, P. LEHMANN, B. DREVET, J. P. GARANDET, D. CAMEL, and F. HERBILLON (CEA, Centre d'Etudes et de Recherches sur les Materiaux, Grenoble, France). *IAF 46th International Astronautical Congress*, Oslo, Norway, 1995, p. 8 (IAF Paper 95-J108). 6 Refs.

Recent results from experiments performed in material science in a microgravity environment, have demonstrated the interest and benefit of noninvasive in-situ measurement techniques. This may be particularly important for crystal growth techniques where the material morphology could be disturbed by foreign sensors located in the liquid/solid phases. We describe the in-situ Seebeck measurement technique and the associated problems to be solved in order to recover a meaningful signal from the crystal growth process. We also show the correlation between the pulling mechanism speed and the real crystal growth rate deduced from the electric resistance variation and also from the Peltier marking. The paper indicates the evolution of such a technique for application in the field of new furnaces development. Presented results are obtained from the MEPHISTO experiments performed during the USMP missions. (Author)

A96-10133 Thermomigration experiment on board EURECA. J. P. PRAIZEY, S. V. VAERENBERGH, and J. P. GARANDET (CEA, Centre d'Etudes Nucleaires de Grenoble, France). *Advances in Space Research* (ISSN 0273-1177), Vol. 16, No. 7, 1995, pp. 205–214. 13 Refs.

Results of thermomigration measurements in liquid tin performed on board EURECA are presented. The aims of the experiment were to measure the thermomigration coefficients of gold and of some tin isotopes in Sn-Au alloys and more generally, to complete the previous results obtained in Spacelab flights of 1983 (FSLP) and 1985 (D1). As in those previous flights, the 'shear cell' technique, allowing a division of the sample in the liquid state, was used. The completion of those results will allow to determine the systems for which microgravity measurements are mandatory. (Author)

A96-10132 Crucible-semiconductor interactions during crystal growth from the melt in space. T. DUFFAR, P. DUSSERRE, and J. ABADIE (CEA, Centre d'Etudes Nucleaires de Grenoble, France). *Advances in Space Research* (ISSN 0273-1177), Vol. 16, No. 7, 1995, pp. 199–203. 5 Refs.

We present the restfits of three recent space experiments of solidification of GaInSb alloys, namely on board TEXUS 31 and 32, Spacelab D2, and EURECA, focusing our attention on the interactions between sample and crucible. Observation of the surface morphology of the samples leads to the conclusion that the dewetting theory agrees well with the experimental results obtained in rough crucibles but that other effects may have an influence on the shape of the samples. Metallographic analysis of the samples show that when dewetting occurs, the crystalline quality of the sample is enhanced. Some practical recommendations are drawn in order to better design the growth of semiconductor crystals in rough crucibles in space. (Author)

A96-10126 Cellular and dendritic solidification of Al-Li alloys during the D2-mission. B. DREVET, D. CAMEL, C. MALMEJAC, and J. J. FAVIER (CEA, Centre d'Etudes Nucleaires de Grenoble, France) and H. N. THI, Q. LI, and B. BILLIA (Aix-Marseille III Univ., Marseille, France). *Advances in Space Research* (ISSN 0273-1177), Vol. 16, No. 7, 1995, pp. 173–176. 7 Refs.

Cellular solidification is one of the major techniques to produce engineering components, since a close control of the microstructure and thus the properties of the material is allowed. During the D2-mission, directional solidification of Al-Li alloys was carried out to study the influence of convection in the liquid phase on the deep cell-dendrite transition and to establish the precise correlation between the interfacial microstructure and the processing parameters. Six samples have been solidified corresponding to different destabilization levels: three alloys in the GFQ and three other in the GHF. By using statistical tools, the primary spacing of the microstructure is calculated. Macrosegregation is determined by chemical analysis. (Author)

A96-10124 High pressure vaporization and burning of methanol droplets in reduced gravity. C. CHAUVEAU, X. CHESNEAU, and I. GOEKALP (CNRS, Lab. de Combustion et Systemes Reactifs, Orleans, France). *Advances in Space Research* (ISSN 0273-1177), Vol. 16, No. 7, 1995, pp. 157–160. 2 Refs.

In the work described here, emphasis is put on recent results obtained in high pressure methanol droplet vaporization and burning experiments conducted both under normal gravity and during the parabolic flights of the CNES Caravelle. The combination of high ambient pressure droplet burning experiments with reduced gravity is crucial in order to reduce the pressure enhanced natural convection effects and also to extend the applicability of the fiber-suspended droplet technique when the surface tension decreases due to the closeness of thermodynamic critical conditions. Low temperature vaporization experiments are conducted in dry air up to 10 MPa, but only under normal gravity conditions because of the longer gasification times. Droplet burning experiments are conducted up to 8 MPa under normal gravity and up to 5 MPa under reduced gravity. The pressure dependencies of the gasification rates for each regime are discussed. (Author)

A96-10122 On the geometry of laminar diffusion flames established over a flat plate burner. J. L. TORERO, L. BONNEAU, J. M. MOST, and P. JOULAIN (Poitiers Univ., Futuroscope, France). *Advances in Space Research* (ISSN 0273-1177), Vol. 16, No. 7, 1995, pp. 149–152. 10 Refs.

An experimental study is conducted on a laminar diffusion flame established over a horizontal flat porous burner. The objective of this study is to provide further understanding on the transport mechanisms controlling a diffusion flame, with particular interest on the role of buoyancy. Fuel (ethane) is injected through the burner and the oxidizer is provided by a forced flow parallel to the surface. Experiments are conducted in normal and microgravity. The parameters varied are the air forced flow velocity, oxygen concentration, and the fuel injection velocity. The flame is found to establish where fuel and oxidizer rates of delivery are in stoichiometric proportions. Experimental results and a scaling analysis of the region close to the flame are compared and the good agreement between theory and experiments confirms the important role of gravity in the determination of the geometry of a diffusion flame. (Author)

A96-10120 Gas-liquid pipe flow under microgravity conditions—Influence of tube diameter on flow patterns and pressure drops. C. COLIN and J. FABRE (Inst. de Mecanique des Fluides, Toulouse, France). *Advances in Space Research* (ISSN 0273-1177), Vol. 16, No. 7, 1995, pp. 137–142. 11 Refs.

Gas-liquid flow experiments have been performed in small tubes of 19, 10, and 6 mm diameter, during parabolic flights, for a range of superficial liquid velocities from 0.1 to 2 m/s and superficial gas velocities from 0.05 to 10 m/s. The flow patterns identified are: bubbly flow, slug flow, and a pattern halfway between slug and annular flows. The main difference between the experiments in small tubes and the previous ones, concerns the transition between bubbly flow and slug flow, the role of coalescence and the wall friction factor. Coalescence is shown to play a major role in the transition from bubbly to slug flow. In particular at small Reynolds number coalescence seems to be partly inhibited. Single-phase flow correlations for wall shear stress underestimate the wall friction factor in the intermediate range of Reynolds number between laminar and turbulent flow. (Author)

N95-14209 Mass transport phenomena in microgravity: Preliminary results of the first MEPHISTO flight experiment. J. J. FAVIER, J. P. GARANDET, A. ROUZAUD, and D. CAMEL. *NASA Marshall Space Flight Center, Joint Launch + One Year Science Review of USML-1 and USMP-1 with the Microgravity Measurement Group*, pp. 27–44 (SEE N95-14207 03-88).

The MEPHISTO space program is the result of a cooperative effort that involves the French nuclear and space agencies (Commissariat a l'energie atomique, CEA—Centre National d'Etudes Spatiales, CNES) and the American National Aeronautics and Space Administration (NASA). The scientific studies and apparatus development were funded in the frame of the GRAMME agreement between CEA and CNES, the flight costs being taken in charge by NASA. Six flight opportunities are scheduled, with alternating French and American principal investigators. It is the purpose of this paper to briefly present MEPHISTO along with the preliminary results obtained during its first flight on USMP-1 in October 1992. (Author)

German Aerospace Literature
This month: *Material Microstructures and Microgravity Experiments*

A97-17391 Thermocapillary instabilities in side-heated liquid layers. D. SCHWABE (Giessen Univ., Germany). *Proceedings of the ESA Space Station Utilisation Symposium*, Darmstadt, Germany, 1996 (A97-17345 03-12), European Space Agency, Noordwijk, Netherlands, 1996, pp. 273–276. 7 Refs.

Marangoni effects, such as thermocapillary flow in differentially heated liquids with free surface, can be studied under microgravity without the coupling with buoyancy forces. Side-heated thin liquid layers are an example with rich physics which justify a long-duration experiment on board the future space station. We briefly describe an experiment with an annular gap and the six different flow states in such a gap known so far from experiments under normal gravity. (Author)

A97-17387 Solidification of immiscible alloys. L. RATKE, G. KOREKT, and S. DREES (DLR, Inst. fuer Raumsimulation, Cologne, Germany). *Proceedings of the ESA Space Station Utilisation Symposium*, Darmstadt, Germany, 1996 (A97-17345 03-12), European Space Agency, Noordwijk, Netherlands, 1996, pp. 247–251. 12 Refs.

A short sketch of an extended R&D program is given dealing with immiscible alloys which will be used as sliding bearings for future car engines. The program is based on the extensive research performed with immiscibles during the last twenty years under reduced gravity conditions. A major achievement had been made during this time: from the results in space, an Earth-based casting routine could be derived which is for the first time able to produce endless strips of alloys suitable for the production of bearings. The casting routine and the material itself need, however, serious improvements in order to become a real industrial process. The R&D program proposed for the space station has two objectives: to improve the material and the casting process. The R&D program is embedded into terrestrial research activities. (Author)

A97-17386 Verification of thermocapillary motion in a decomposing monotectic alloy melt. H. KLEIN and L. RATKE (DLR, Inst. fuer Raumsimulation, Cologne, Germany) and H. NEUMANN (Chemnitz-Zwikau, Technische Univ., Chemnitz, Germany). *Proceedings of the ESA Space Station Utilisation Symposium*, Darmstadt, Germany, 1996 (A97-17345 03-12), European Space Agency, Noordwijk, Netherlands, 1996, pp. 243–246. 15 Refs.

An experiment is proposed to verify thermocapillary motion of second phase droplets in a decomposing melt of a monotectic alloy. The sample system used is the system Al/Bi. The temperature gradient to induce thermocapillary motion is caused by an electrical heated wire. Phase separation due to thermocapillary motion is monitored by using electrical resistance measurements. (Author)

A97-12888 Axisymmetric damped frequencies of a rotating finite visco-elastic liquid column. H. F. BAUER and W. EIDEL (Muenchen Univ. der Bundeswehr, Neubiberg, Germany). *Acta Astronautica* (ISSN 0094-5765), Vol. 38, No. 9, 1996, pp. 689–698. 20 Refs. Documents available from AIAA Dispatch.

The assumption of Maxwell is used to investigate a liquid column of finite length consisting of a viscoelastic liquid. A viscoelastic liquid is found to exhibit a greater readiness to oscillate than a viscous liquid. Viscoelasticity is shown to yield a larger decay magnitude and larger oscillation frequencies. The root, which shows aperiodic motion for a viscous liquid, exhibits oscillatory behavior for a viscoelastic fluid, given a certain small liquid height ratio. A growth in σ^* or a decrease in the Ohnesorge number increases both the decay magnitude and the oscillation frequency. For larger viscosities the viscoelastic liquid exhibits smaller decay and a smaller oscillation frequency.

A96-44786 On the transition of solidification mechanisms in highly undercooled germanium. D. LI, K. ECKLER, and D. M. HERLACH (DLR, Inst. fuer Raumsimulation, Cologne, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 517–522. 10 Refs.

Large undercoolings of up to Δ-T = 426 K for pure germanium were reproducibly obtained using the containerless EM levitation technique. The crystal growth behavior and grain structure developments of Ge are studied as a function of the bulk undercooling, Δ-T. Three undercooling regions of different growth behavior and morphologies are identified: 1) lateral growth (LG) for Δ-T less than 300 K (the typical lamellar twins (111) 211 line were grown at the lower end of this region, whereas, at the higher end, a mixed structure appeared); 2) continuous growth (CG) beyond a threshold undercooling (the crystal growth velocity, V, increases rapidly at Δ-T = 300 K, which is evidence for a transition from LG to CG); and 3) rapid crystal growth (homogeneous grain refinement was observed in bulk pure Ge samples when V is not less than 0.8 m/s for Δ-T not less than 400 K. In the CG range, the measured growth velocities agree well with slightly modified, current dendrite growth theory). (Author)

A96-44782 Nonequilibrium crystal growth and kinetic roughening in greatly undercooled Ge and Ge-2 at.% Sn. D. LI, K. ECKLER, and D. M. HERLACH (DLR, Inst. fuer Raumsimulation, Cologne, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 489–494. 16 Refs.

Containerless EM levitation processing was used to undercool pure Ge and Ge-2 at.% Sn alloy up to 426 and 368 K, respectively. The crystal growth velocities in undercooled melts were directly measured with a photodiode technique. Experiments and calculations with the slightly modified current dendrite growth theory have shown that solidification mode was transformed from lateral growth, to continuous growth, and eventually to rapid growth, as the driving force for crystallization, i.e., undercooling was increased, correspondingly leading to faceted twins, randomly oriented dendrites, and refined equiaxed grains. It was found that a small addition of solute Sn to pure Ge made roughening of the solid–liquid (S/L) interface occur at a lower undercooling, and the growth velocities rise markedly. (Author)

A96-44767 Evidence for a coupled growth of the properitectic α-Ti and the peritectic-TiAl in binary titanium aluminides. J. LAAKMANN, P. BUSSE, S. RUELLENRATH, and F. MEISSEN (ACCESS, Aachen, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 355–362. 13 Refs.

Binary titanium aluminides with concentrations in the range of 48–54 at.% aluminum were solidified directionally using a Bridgman unit. The temperature gradient exceeded 17 K/mm, and the withdrawal velocity v was between 0.025 and 10 mm/min. Alloys with concentrations up to 52 at.% aluminum solidify in primary α-dendrites with interdendritic γ-TiAl. Decreasing the withdrawal velocity or the aluminum concentration suppresses the creation of secondary dendrite arms and coarsens the microstructure. A completely different microstructure is exhibited by alloys with 54 at.% Al at very low solidification velocities. This microstructure consists of two phases growing parallel to the growth direction. To explain the above-mentioned behavior an extended model of stationary peritectic reaction, including gravity-driven effects like sedimentation and convection, is discussed. A directional solidification experiment under reduced gravitation is proposed to validate this model. (Author)

A96-44759 Directional solidification of Al-Al_3Ni eutectic alloys in an aerogel furnace. T. BUCHHOLZ and J. ALKEMPER (DLR, Inst. fuer Raumsimulation, Cologne, Germany); K. MURAKAMI (NASDA, Tsukuba, Japan); and L. RATKE (DLR, Inst. fuer Raumsimulation, Cologne, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 291–296. 9 Refs.

Directional solidification experiments of eutectic Al-Al_3Ni alloys have been performed using a new facility named ARTEMIS. This facility allows good control of the solidification parameters, especially the velocity of the solidification front and the temperature gradient ahead of the solid–liquid interface. On vertical cuts through the samples the distance of the Al_3Ni fibers lambda was measured and plotted vs the solidification velocity. The results fit the Jackson and Hunt prediction of $\lambda * \nu_2 = \text{const}$. The microstructure of the solidified Al-Al_3Ni alloys shows clear differences between samples solidified with constant and those solidified with varying solidification parameters. These differences are analyzed with various techniques and are discussed. (Author)

A96-44757 Experimental results to the displacement of droplets by the solidification front in near monotectic alloys. H. NEUMANN and C. KUEHTZ (Chemnitz-Zwickau, Technische Univ., Chemnitz, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 277–282. 10 Refs.

Near monotectic Zn-Pb alloys quenched in water show a border with only a small proportion of the minority phase on the lateral area of the specimen. Using calculated temperature fields, the velocity of Pb-droplets moving by the radial temperature gradients and the velocity of the solidification front are determined. From the comparison of both velocities it is concluded that a displacement of droplets by the solidification front caused the border of impoverishment. (Author)

A96-44755 Numerical modelling of microstructure evolution in castings of immiscible alloys. S. DRESS and L. RATKE (DLR, Inst. fuer Raumsimulation, Cologne, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 265–270. 10 Refs.

The discrete multiparticle approach (DMPA), a newly developed numerical simulation technique, is presented together with one application of it: the evaluation of the results from a D-2 experiment on immiscibles. The DMPA enables the numerical modeling of the phase separation and solidification of alloys that are immiscible as melts like aluminum, lead, or bismuth. (Author)

A96-44754 Evolution of the microstructure during solidification of immiscible alloys. L. RATKE (DLR, Inst. fuer Raumsimulation, Cologne, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 251–264. 33 Refs.

This paper discusses some recent experimental and theoretical progress on microstructure evolution during solidification of alloys exhibiting a miscibility gap in the liquid state, revealing the importance of all physical processes that occur in a region ahead of the solid/liquid interface where the liquid is thermodynamically in the two-phase liquid regime. These processes are nucleation of the minority phase as drops, their diffusional growth, Stokes sedimentation, Marangoni motion, and coagulation of drops. Comparison of experimental results under Earth and reduced gravity conditions with theoretical models reveal that these processes occurring while passing the miscibility gap seems to be of more importance than the interaction of the second phase drops with the solid/liquid interface. Advantages and limitations of the theoretical modeling based on population dynamics are discussed. (Author)

A96-44749 Directional solidification of succinonitrile within the porous network of an aerogel. K. GROSSE and L. RATKE (DLR, Inst. fuer

Raumsimulation, Cologne, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 215–222. 9 Refs.

Static light scattering is used to study the solidification of succinonitrile (SCN) within the nanoporous structure of aerogels. Molten SCN, infiltrated into the porous network of silica aerogels, is directionally solidified and remelted with various temperature gradients and solidification front velocities. We observe that solidification occurs over a wide range beginning from the equilibrium freezing temperature to undercoolings of up to 20 K below it. The wide freezing range is explained by pure capillary undercooling due to the spectrum of pore sizes ranging from a few nanometers to a few microns. It is shown by repeated solidification and remelting that the fragile aerogels are not destroyed by the infiltration process, since the light scattering pattern is unaltered. The scattered light intensity profile is described with the Debye model of light scattering in a random inhomogeneous media, assuming a certain pore size distribution in the aerogel. During remelting a hysteresis of several degrees in the melting temperature, whose origin is explained by dynamic wetting, is observed. (Author)

A96-44739 Morphology and segregation behavior in directionally solidified copper-manganese alloys with compositions near the melting point minimum. G. ZIMMERMANN and A. SCHIEVENBUSCH (ACCESS, Aachen, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 133–140. 6 Refs.

Recent results in directional solidification experiments with Cu-Mn alloys with compositions near the melting point minimum showed that this binary alloy is well suited for investigations on fundamental aspects of macrosegregation and interface morphology as well. Several experiments with alloy concentrations lower than 32.8 wt% Mn carried out on Earth confirm the existence of the melt convection, whereas purely diffusive experiment conditions were realized in microgravity during the D-2 Spacelab Mission. Increasing of the solidification velocity results in cellular and dendritic solid-liquid interface morphologies. From excellent metallographical prepared cross sections, especially the spatio-temporal development of cellular patterns, i.e., mainly the primary spacings, regularity and anisotropy of the cells, providing the basis for the improvement of theoretical models, have been investigated. (Author)

A96-44734 Polyurethane foams formed in a microgravity environment. K. KUECK, S. LUTZ, and M. MEIER (Bremen Univ., Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 101–108. 6 Refs.

The influence of compensated gravity on the formation and structure of bubbles within polyurethane foams is investigated as part of a student experiment. Cross-linked polyurethanes are often used as foams, either in a rigid or a soft form. For the preparation of rigid foams an experimental setup suited for use in flight experiments was constructed. Ground experiments are carried out before in order to optimize the rise process through parameter variation. Following that, flight experiments at the Bremen drop tower were performed to investigate the change of the cell structure under micro-*g* conditions. Evaluation by means of digital image analysis showed no influence of micro-*g* conditions on the shape, but on the volume of the bubbles. The mean bubble radius of the micro-*g* samples is up to two times higher compared with foams processed under normal conditions. (Author)

A96-44733 A new type of drop tube. M. MEIER, O. HINRICHS, and H. J. RATH (Bremen Univ., Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 95–99.

A disadvantage of all known drop tubes (DTs) is the lack of a continuous measurement possibility during the free fall. The idea for a new type of DT was the combination of a DT with a drop capsule. At the first stage, a DT with 5-m free fall height, corresponding to 1-s micro-*g* time is constructed (at the second stage the height will be 12 m), operating at a pressure between 1–10 exp −4 bar. At the top an automated sample positioning device places rods or fibers of the sample material in a gradient furnace (pendant drop method). When the melt droplet starts falling, an instrumented platform will be released and catch the droplet in a chamber. The chamber is closed during the free fall. The platform is accelerated by an electric linear drive and guided in tracks. By means of a regulation, the relative velocity between chamber and droplet will be nearly zero. The platform is equipped with a CCD camera, a pyrometer, and light barriers measuring the relative velocity, position, diameter, and temperature of the droplet. When the decelaration is finished, the chamber opens below and the decelerated, solidified droplet falls into an automated sampling mechanism. (Author)

A96-44731 Chill casting of Al-Pb- and Al-Bi-alloys in aerogel crucibles during a parabolic flight. G. KOREKT and L. RATKE (DLR, Inst. fuer Raumsimulation, Cologne, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 81–87. 9 Refs.

Hypermonotectic Al-Pb and Al-Bi alloys were solidified on Earth under normal gravity and under reduced gravity conditions of a parabolic flight. The cast microstructure obtained in a reduced gravity environment is dominated by Marangoni-motion of the Pb- or Bi-droplets. Samples processed under 1-*g* conditions are evidently dominated by Stokes settling of the droplets. A theoretical model is presented treating the microstructure evolution as a concurrent action of nucleation, diffusional growth, and Marangoni-motion of Pb- and Bi-droplets. The theoretical prediction for the volume content of Pb and Bi agrees reasonably well with the experiments. The biggest observable drop radius as a function of position in the sample agrees with the theoretical prediction if collision and coagulation events are taken into account. (Author)

A96-44727 Grain refinement in solidification of undercooled Ni-Cu melts. K. ECKLER and M. SCHWARZ (DLR, Inst. fuer Raumsimulation, Cologne, Germany); A. KARMA (Northeastern Univ., Boston, MA); and D. M. HERLACH (DLR, Inst. fuer Raumsimulation, Cologne, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 45–50 (Grant DE-FG02-92ER-45471). 12 Refs.

The microstructures of bulk Ni-Cu samples solidified from the undercooled melt are investigated. High levels of undercoolings were attained by containerless processing in an EM levitation facility. At both high and low undercoolings reached prior to nucleation, a grain-refined equiaxed microstructure is formed, whereas for intermediate undercoolings a coarse dendritic microstructure is observed. The transitions between the microstructures take place quite abruptly at critical values Δ-T^* of the undercooling. The dependence of the values of Δ-T^* on the composition is studied, leading to the construction of a microstructure-selection map for the Ni-Cu system. The results are discussed within the scope of a new model for grain refinement featuring the fragmentation of the primary dendrites. (Author)

A96-43982 User support for material sciences experiments during the ESA EuroMir '95 mission. G. OTTO, M. EXNER, R. NAEHLE, R. ROESTEL, H. P. SCHMIDT, G. SCHMITZ, and K. WITTMANN (DLR, Inst. fuer Raumsimulation, Cologne, Germany) and J. STROEDE (ESTEC, Noordwijk, Netherlands). *IAF 47th International Astronautical Congress*, Beijing, China, 1996, p. 10 (IAF Paper 96-J502). 5 Refs.

A long-duration manned mission of 179 days by astronaut T. Reiter to the space station Mir was performed by ESA during 1995–96. Among others, he also operated the multi-user facility TITUS (Tubular Furnace With Integrated Thermal Analysis Under Space Conditions). Eight investigators used this newly installed furnace for material sciences experiments in the topics of undercooling, phase separation, solidification, and vapor transport. The yield could be increased further by repeating several experiments because of a mission extension of 44 days. Extensive user support for the investigations was provided by MUSC (Microgravity User Support Center) with an engineering model of the furnace. A sophisticated, easy-to-use crew interface software was designed and implemented. During the mission, data by video, voice, or digital form were available in the Experiment Control Room on the MUSC premises, and the experiments were supervised from there. An early handover of processed samples to the investigator was made possible by the Space Shuttle visiting the Mir station in November 1995. Transmission of recorded temperature and selected microgravity data from the TITUS facility was achieved with the Mir telemetry system (BITS). These data were routed via the Russian Control Center in Moscow (TsUP) and SCOPE near Munich to MUSC. In addition, all data were stored on PMCIA cards and returned to Earth with the processed cartridges. (Author)

A96-43961 Effective cooling of electronic components by boiling phase transition in microgravity. J. STRAUB and G. PICKER (Muenchen Technische Univ., Munich, Germany) and J. WINTER and M. ZELL (Daimler-Benz Aerospace AG, Friedrichshafen, Germany). *IAF 47th International Astronautical Congress*, Beijing, China, 1996, p. 10 (IAF Paper 96-J208). 9 Refs.

Boiling heat transfer on a miniature heater has been studied under microgravity conditions during the IML 2 Space Shuttle Mission in 1994. These experiments are simulations for the application of the direct cooling of small electronic devices by boiling heat transfer in space. This becomes very important due to high thermal loads of modern electronic components. The results of this investigation show that, even at microgravity, the heat transfer coefficients are very high and are even higher compared with other heater geometry. A remarkable influence of the gravity on the nucleate boiling heat transfer could not be observed; only in the transition and film boiling region a reduction up to 50% was found. Several boiling modes have been observed during the experimental runs depending on the subcooling of the liquid, the liquid state, and the overall heat flux. Surface tension, wetting behavior, coalescence processes, the momentum of bubble formation, and thermocapillary convection play the most important role in boiling. The general statement can be made that boiling can be applied for cooling processes in microgravity. (Author)

A96-41878 On the influence of buoyancy on the surface tension driven flow around a bubble on a heated wall. G. WOZNIAK, K. WOZNIAK, and H. BERGELT (Freiburg Technische Univ., Germany). *Experiments in Fluids* (ISSN 0723-4864), Vol. 21, No. 3, 1996, pp. 181–186. 5 Refs.

The surface tension-driven flow in the liquid vicinity of gas bubbles on a heated solid wall was investigated both in a reduced gravity environment aboard a sounding rocket and in an Earth-bound experiment. Both experiments dealt with temperature gradients within the liquid surroundings of a bubble which cause variations of the surface tension. These in turn lead to a liquid flow around the bubble periphery termed thermocapillary or thermal Marangoni convection. On Earth, this phenomenon is widely masked by buoyancy. We therefore carried out an experiment under reduced gravitational acceleration. To simultaneously observe and record the flow field and the temperature field, liquid crystal tracers were applied. These particles offer the feature of selectively reflecting certain wavelengths of incident white light depending on the crystals' temperature. Comparison of results obtained in microgravity to data measured on Earth reveal that, due to the interaction of thermocapillarity and buoyancy, a very compact vortex flow results on the ground, while in microgravity the influence on the surface tension driven flow penetrates much deeper into the bulk. This result is of special interest regarding the production of materials in space. (Author)

A96-37481 Measurements of isochoric heat capacity $c(v)$ at the critical point of SF6 under microgravity—Results of the German Spacelab Mission D2. J. STRAUB and A. HAUPT (Munich Technical Univ., Germany). *Proceedings of the 19th International Symposium on Space Technology and Science*, Yokohama, Japan, 1994 (A96-37401 10-12), Agne Shofu Publishing, Inc., Tokyo, Japan, 1994, pp. 635–646. 19 Refs.

During the Second German Spacelab Mission D2 the isochoric specific heat of SF6 was measured along the critical isochore under microgravity with a newly developed scanning radiation calorimeter. This calorimeter makes it possible to perform comparable heating and cooling runs with variable ramp rates, since the spherical sample cell is heated and cooled only by radiation. Approaching the critical temperature by cooling from the homogenous 1-phase region avoids significant temperature and density differences in the fluid which would falsify the integral measurement of the specific heat. Small inhomogenities of the temperature and density field introduced during cooling in the 1-phase region by a finite ramp rate are dissolved by the effect of fast dynamic temperature propagation. In the 2-phase region the high precision of the measurements is ensured by the existence of a dispersion of small droplets, and bubbles resulting in a short length for the heat and mass transport during the phase separation. The $c(v)$ data achieved with slow cooling runs are in remarkably good agreement with previous experimental investigations. (Author)

A96-34701 The micro wedge model—A physical description of nucleate boiling without external forces. J. STRAUB (Muenchen Technische Univ., Munich, Germany). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin, (Lecture Notes in Physics. Vol. 464), 1996, pp. 351–359. 11 Refs.

Boiling experiments performed during the past years in microgravity environment obviously demonstrate that the existing theoretical models or semiempirical correlations extrapolated to lower gravity levels are in contradiction to the experimental findings. The overall heat transfer is hardly influenced by gravity while the bubble dynamics itself is strongly affected. Obviously external forces like gravity in pool boiling and shear forces in flow boiling only play a secondary role, while internal ones govern the process like interfacial forces. Based on these observations, a microwedge model is proposed which can be regarded as an improvement of the microlayer model. (Author)

A96-34698 Thermocapillary convection in liquid bridges with a deformed free surface. V. M. SHEVTSOVA, H. C. KUHLMANN, and H. J. RATH (Bremen Univ., Germany). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin, (Lecture Notes in Physics. Vol. 464), 1996, pp. 323–329. 5 Refs.

The two-dimensional thermocapillary flow in a liquid bridge of aspect ratio one with a curved free surface is investigated. The Stokes flow solution near the hot and cold corners becomes singular at a critical contact angle of 128.7 deg. Beyond this angle, the flow should reverse locally. The length scale below which the flow reversal is expected cannot be predicted by the simple Stokes flow analysis. Numerical simulations indicate that the extention of the flow reversal region should be less than 10 exp −4 in units of the height of the liquid bridge when the contact angle is 135 deg. (Author)

A96-34691 Containerless processing in space—Recent results. *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin, (Lecture Notes in Physics. Vol. 464), 1996, pp. 233–252. 17 Refs.

During the International Microgravity Laboratory Mission 2 (IML-2) on board the Space Shuttle Columbia, the containerless processing facility TEMPUS had its maiden flight. A team of eight Principal Investigators from the U.S. and Germany performed a number of experiments on liquid metals and alloys. TEMPUS is an electromagnetic levitation facility designed to operate under microgravity conditions. It allows to melt and undercool metallic samples of 8 mm diam, with no contact to a crucible. Thus, experiments on nucleation statistics, nonequilibrium solidification, and measurements of thermophysical properties are possible. During IML-2, 22 samples of different compositions were processed, including pure metals such as Au, Ni, Zr, as well as eutectic alloys, for example NiNb and ZrNi. In addition, the solidification behavior of quasi-crystal forming alloys (AlCuFe and AlCuCo) was studied. This paper discusses the results of these experiments and the difficulties in obtaining them. (Author)

A96-34685 Microstructure evolution in immiscible AlSiBi alloys under reduced gravity conditions. L. RATKE, S. DREES, and S. DIEFENBACH (DLR, Inst. fuer Raumsimulation, Cologne, Germany); B. PRINZ (Metallgesellschaft, Frankfurt, Germany); and H. AHLBORN (Hamburg–Harburg Technische Univ., Hamburg, Germany). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin (Lecture Notes in Physics. Vol. 464), 1996, pp. 115–133. 23 Refs.

Strip cast Al-Si-Bi alloys were directionally melted and solidified in the Isothermal Heating Facility (IHF) of the Werkstofflabor on board the Spacelab mission D2. The main objective of the experiment was to investigate the microstructure evolution during melting and solidification in alloys exhibiting a miscibility gap in the liquid state. The microstructure rearranges from an evenly distributed dispersion of solid bismuth particles in a solid AlSi matrix due to thermocapillary motion of Bi-rich droplets during melting and solidification in microgravity. The strip casting process provides a material with a well-defined particle dispersion. Two experiment runs were performed successfully. Samples with a Bi-content of 7 wt% and two different melting rates were melted and solidified. Their as-solidified microstructures clearly show that the Bi droplets moved by thermocapillary motion, as anticipated. The mean size of the droplets increased by a factor of two, and the droplet size distribution exhibits a maximum with very big droplets, revealing that the coalescence of drops contributed to the coarsening of the dispersion. The results are analyzed with a numerical model. (Author)

A96-34684 Growth of 20 mm diameter GaAs crystals by the floating zone technique during the D-2 Spacelab Mission. G. MUELLER and F. M. HERRMANN (Erlangen–Nuernberg Univ., Erlangen, Germany). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin (Lecture Notes in Physics. Vol. 464), 1996, pp. 105–113. 15 Refs.

Five GaAs single crystals Si-doped and undoped with diameters of 20 mm were grown by the floating-zone-technique (FZ) under microgravity during the second German Spacelab Mission D2. The GaAs rods were sealed in silica ampoules which contained an integrated As source to provide controlled stoichiometry conditions. The heating system consisted of a specially designed mirror furnace. The results show that stoichiometric material was achieved within the limits of error of a coulometric analysis. The occurrence of dislocation networks could be strongly reduced and nearly avoided. Both oxygen and boron contents of the space-grown crystals are very low. Results of numerical calculations of the curvature of the interface, the distribution of temperature and stress in the crystal are shown to be in good agreement with the experiments. (Author)

A96-34680 Critical depletion of pure fluids in colloidal solids—Results of experiments on EURECA and grand canonical Monte Carlo simulations. M. THOMMES, M. SCHOEN, and G. H. FINDENEGG (Berlin Technische Univ., Germany). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin (Lecture Notes in Physics. Vol. 464), 1996, pp. 51–59. 14 Refs.

A microgravity experiment on the EURECA-1 mission of ESA was performed to study the adsorption of a near-critical fluid (SF6) on a finely dispersed graphitic adsorbent (Vulcan 3-G graphitized carbon). The EURECA experiment confirmed a novel critical sorption phenomenon, which is due to the colloidal state of the adsorbent. At temperatures well above the critical temperature, the adsorption excess amount increases with decreasing temperature, but closer to the critical temperature, exhibits a maximum and then decreases sharply for temperatures approaching the critical temperature. The phenomenon was also observed for near-critical isochores of SF6 in a mesoporous glass material. Grand canonical Monte Carlo simulations for a fluid in a slit-pore suggest that the negative critical adsorption effect is caused by depletion in the core region of the pore as the temperature approaches the critical temperature. This effect, which we call critical depletion, is believed to be driven by the proximity of the bulk fluid to its critical point. (Author)

A96-34679 Adsorption kinetics and exchange of matter at liquid interfaces and microgravity. H. FRUHNER (Potsdam Univ., Germany) and K. LUNKENHEIMER and R. MILLER (Max-Planck-Inst. fuer Kolloid- und Grenzflaechenforschung, Berlin, Germany). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin (Lecture Notes in Physics. Vol. 464), 1996, pp. 41–50. 43 Refs.

The oscillating bubble set-up allows accurate measurements of relaxation processes of surfactant, protein, and mixed surfactant/protein adsorption layers in a frequency interval from few Hz up to several hundred Hz. Experimental dependencies of dilational elasticity as a function of oscillation frequency obtained for some surfactant solutions are in good agreement with a diffusional exchange of matter theory. The relaxation behavior of gelatin adsorption layers shows no significant dependence in the studied frequency interval as remarkable changes are expected at much lower frequencies. However, in the presence of a surfactant, the mixed protein/surfactant adsorption layer shows a linear dependence $E(f)$ which would be in line with a dilational viscosity effect. The instrument has the capacity to be used also for adsorption kinetics studies by enlarging the bubble surface several times its initial area at the beginning of the experiment and then recording the pressure change with time. (Author)

A96-34676 Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences, Berlin, Germany, 1995. L. RATKE (DLR, Inst. fuer Raumsimulation, Cologne, Germany); H. WALTER (ESA, Paris, France); and B. FEUERBACHER, EDS. Springer–Verlag, Berlin (Lecture Notes in Physics. Vol. 464), 1996, p. 441 (For individual items see A96-34677–A96-34706). ISBN 3-540-60677-7. Documents available from AIAA Dispatch.

The papers presented in this volume provide an overview of recent results in microgravity research and applications. The general areas covered include critical point phenomena and adsorption; solidification; crystallization; fluid statistics and thermophysical properties; fluid dynamics; and combustion. Specific topics discussed include numerical solutions of thermoacoustic and buoyancy-driven transport in a near critical fluid; dendritic growth measurement in microgravity; response of crystal growth experiments to time-dependent residual accelerations; containerless processing in space; nonuniform interfacial tension-driven fluid flows; and combustion processes under microgravity conditions.

Italian Aerospace Literature
This month: *Microgravity Experiments*

A97-17390 The FAST project—Surface tension and adsorption studies in microgravity. L. LIGGIERI, F. RAVERA, and A. PASSERONE (CNR Ist. di Chimica Fisica Applicata dei Materiali, Genoa, Italy). *Proceedings of the ESA Space Station Utilisation Symposium*, Darmstadt, Germany, 1996 (A97-17345 03-12), European Space Agency, Noordwijk, Netherlands, 1996, pp. 265–271. 16 Refs.

The Facility for Adsorption and Surface Tension studies (FAST) has been successfully proposed in the framework of the Columbus Precursor Flight activities, and it is now scheduled for the first flight as a SPACEHAB module in 1998. In this paper, the basic working principle of the Capillary Pressure Tensiometer, which is the core of the facility, and the main lines of the three selected experiments for this first flight are summarized. All these experiments deal with the adsorption kinetics of soluble surfactants for which diffusion plays a fundamental role. Due to the large attenuation of convective fluxes, microgravity provides an ideal environment for studying adsorption processes in purely diffusive conditions. (Author)

A97-17381 Influence of *g*-jitter on fluid physics experimentation onboard the International Space Station. R. MONTI and R. SAVINO (Napoli Federico II Univ., Naples, Italy). *Proceedings of the ESA Space Station Utilisation Symposium*, Darmstadt, Germany, 1996 (A97-17345 03-12), European Space Agency, Noordwijk, Netherlands, 1996, pp. 215–224. 14 Refs. Grant ESA-11597/95/F/FL.

g-jitter effects on fluid physics microgravity experimentation are investigated by theoretical analysis and numerical simulation. It is shown that temperature and/or concentration gradients, in the presence of high frequency vibrations, may give rise to time-averaged convective flows during fluid dynamics and material science experimentation. In particular, in the range of frequencies of interest for the International Space Station (ISS), the oscillatory parts of the temperature and/or concentration distortions are negligible when compared to their time-averaged counterparts, induced by the time-averaged velocity field. As a study case, a microgravity experiment is proposed to investigate the transient vibrational convection regimes in a fluid cell in the presence of temperature gradients on board the ISS. Preliminary experimental activities are being performed on ground, complemented by numerical simulations for the comparison of the TFD fields with and without Isolation Mount. (Author)

A97-15789 Experimentation with the COLLAGEX facility. A. GILY, A. D. MASI, and P. VACCANEO (Alenia Spazio S.p.A., Turin, Italy); L. CAROTENUTO (MARS Center, Naples, Italy); and S. MUSAZZI (CISE, Milan, Italy). *AIAA 35th Aerospace Sciences Meeting and Exhibit*, Reno, NV, 1997, p. 7 (AIAA Paper 97-0779). 8 Refs.

The development of a facility for the investigation of colloid aggregation in microgravity has been started under contract from ESA. The facility, called COLLAGEX, is designed to support a number of different experiments in successive missions. The baseline instrumentation supports low- and wide-angle light scattering, dynamic light scattering, video observation, and thermal control of the sample. Further instrumentation may be accommodated on the basis of the experimental requirements. In addition to the study of colloids, COLLAGEX is suitable for research in a number of different fields, for example, protein crystallization. (Author)

A96-43969 The scientific results of INEX-MAM—Interactive EXperiment on Marangoni Migration. R. FORTEZZA and D. CASTAGNOLO (MARS Center, Naples, Italy) and R. MONTI (Naples Univ., Italy). *IAF 47th International Astronautical Congress*, Beijing, China, 1996, p. 9 (IAF Paper 96-J308).

The objective of the INEX-MAM experiment is to investigate the migration of bubbles injected in a liquid matrix in a nonuniform temperature field. The experiment was performed onboard the TEXUS 34 sounding rocket in March 1996. During a few minutes of low gravity environment, bubbles were injected under controlled conditions (temperature, pressure, and residual gravity) in a liquid matrix obtained by melting a succinonitrile sample. The experiment was fully controlled from MARS, where the scientific team was located. This paper reports some scientific results obtained by observing the migration of these bubbles in the liquid matrix, and some comparisons with theoretical results available in the literature. (Author)

A96-37867 A beam deflection apparatus with high resolution for monitoring TGS crystal growth. S. MUSAZZI (CISE, Segrate, Italy); A. AFFINITO (Milan Univ., Italy); and C. STENZEL and G. FABRITIUS (Dornier GmbH, Friedrichshafen, Germany). *Space processing of materials; Proceedings of the Conference*, Denver, CO, 1996 (A96-37836 10-29), Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 2809), Bellingham, WA, 1996, pp. 277–287. 5 Refs.

A beam deflection apparatus with a high resolution has been developed which allows monitoring of temperature and concentration gradients in the region around a TGS (triglycine sulphate) crystal growing from an aqueous solution. The setup consists of two measuring arms that allow inspection of the test region along two perpendicular directions. With a lateral position sensing device, the deflection of a mildly focused laser beam traversing the medium to be tested have been measured along one inspection axis, while a two-dimensional analysis of the test region is performed in the orthogonal direction by means of a properly focused light blade and a CCD camera. Experimental verification has been performed using TGS crystal growth by means of the cooled sting method. The experiment takes place in a double-wall glass cell, the temperature of the TGS crystal can be adjusted independently from the solution temperature. Systematic measurements characterize concentration gradients and thermal convection in the vicinity of the crystal. This technique is well suited as a diagnostic tool for monitoring and controlling crystal growth experiments in microgravity. (Author)

A96-34688 Fluid-dynamic modelling of protein crystallyzers. R. MONTI and R. SAVINO (Napoli Univ., Naples, Italy). *Materials and fluids under low gravity; Proceedings of the 9th European Symposium on Gravity-Dependent Phenomena in Physical Sciences*, Berlin, Germany, 1995 (A96-34676 09-29), Springer–Verlag, Berlin (Lecture Notes in Physics. Vol. 464), 1996, pp. 171–194. 17 Refs.

A fluid-dynamic model of the hanging (or sitting) drop is proposed to study the time evolution of the thermo-solutal flow fields in protein crystallizers. An order of magnitude analysis of the vapor phase surrounding the drop shows that buoyancy effects are negligible in the vaporization chamber and that the evaporation is a very fast process, so that the rate of evaporation is controlled essentially by water diffusion through the air space. The cases considered refer to the crystallization of lysozyme in a solution of NaCl in water. Preliminary numerical results are shown corresponding to zero-*g* and to one-*g* (with and without Marangoni effect). The computations seem to indicate that, in the prenucleation phase, the Marangoni effects may be relevant at 0-*g* for the full drop. For the half-drop geometry, Marangoni flows may play only a role on the ground. In the post-nucleation phase the comparison between 0-*g* and 1-*g* shows that in ground conditions the mass transfer is enhanced by convection, and therefore the crystal growth rate increases, but the nonunifcrmity in the interface concentration gradients around the growing crystal may have a detrimental effect on the growth kinetics. (Author)

A96-10472 Numerical solutions of three-dimensional convection in cylinders. A. VIVIANI (Napoli II Univ., Aversa, Italy); C. GOLIA (Centro Italiano Ricerche Aerospaziali, Capua, Italy); and M. CIOFFI (Napoli II Univ., Aversa, Italy). *IAF 46th International Astronautical Congress*, Oslo, Norway, 1995, p. 23 (IAF Paper 95-J304). 12 Refs.

The understanding of convection in cylindrical geometries is a topic of practical interest for many applications of material processing, and in particular it is useful in the field of crystallization by vapor growth. For most of such applications the growth ampules are circular cylinders with two relevant configurations with respect to the gravity vector: horizontal and vertical. In the present study we shall consider a horizontal cylinder with differentially heated end-walls and a vertical cylinder heated from below, by analyzing the complex three-dimensional flow structure for configurations relevant to crystal growth by vapor transport. The unsteady Navier–Stokes equations are solved in terms of vorticity-velocity variables via a constant-in-time Galerkin finite element semi-implicit method. The code has been optimized on a high-performance vector-parallel computer, where the seven linear symmetric positive-definite algebraic systems, resulting from the temperature, three vorticity and three velocity equations, are solved in parallel. (Author)

A96-10464 Relevance of Burnett stresses and side-wall creep in microgravity crystal growth from vapour phase. A. VIVIANI and C. GOLIA (Napoli II Univ., Aversa, Italy). *IAF 46th International Astronautical Congress*, Oslo, Norway, 1995, p. 23 (IAF Paper 95-J203). 14 Refs.

This paper deals with binary mixture flows caused by nonuniform temperature and concentration distributions in longitudinal ampules used for vapor crystal growth. The general case, where convection is driven not only by usual vapor transport mechanisms (buoyancy and Stefan–Nusselt flow) but also by nonNavier–Stokes effects (Burnett stresses and side-wall creep) is considered. The field equations are solved by means of a two-dimensional finite difference numerical code in terms of vorticity and stream function. The results are discussed for typical conditions of physical vapor transport processes and for different gravity levels, ranging from normal gravity to zero gravity conditions. For each case, the results of the Burnett equations are compared with the corresponding solution of the Navier–Stokes approximation, discussing the main features of the flow pattern and showing that under microgravity conditions, where gravity-driven flows are negligible, the Burnett and creep effects become significant. (Author)

A96-10113 Marangoni flows and coalescence phenomena in microgravity. P. DELL'AVERSANA, R. MONTI, and F. S. GAETA (Napoli Univ., Naples, Italy). *Advances in Space Research* (ISSN 0273-1177), Vol. 16, No. 7, 1995, pp. 95–98. 14 Refs.

Experiments on the ground and in microgravity are reported which show that, under well-defined conditions, the coalescnece of two drops of the same liquid can be prevented, a stable interface being formed instead. A state of motion of the liquid surfaces contributes to this phenomenon. Motions that hinder coalescence may be generated both by Marangoni flow induced by temperature gradients and by mechanical maens. (Author)

United Kingdom Aerospace Literature
This month: *Material Microstructures and Microgravity Experiments*

A96-44726 Microstructural development in undercooled and quenched Ni_3Al droplets. H. ASSADI (Cambridge Univ., UK); M. BARTH (DLR Inst. fuer Raumsimulation, Cologne, Germany); A. L. GREER (Cambridge Univ., UK); and D. M. HERLACH (DLR, Inst. fuer Raumsimulation, Cologne, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 37–44. 10 Refs.

Rapidly solidified droplets of nickel-rich Ni_3Al were produced by means of EM levitation followed by quenching in liquid Ga-In-Sn. The antiphase domain (APD) patterns have been characterized by TEM, and three distinct regions can be identified within grains of Ni-23.5 at.% Al droplets: an anomalous central region of coarse APDs, the main volume of the grain with fine APDs, and coarse APDs near the grain boundary. Possible explanations for the formation of this particular microstructure are considered and assessed in relation to solidification models and further microstructural observations. (Author)

A96-44725 Use of texture analysis for the characterisation of Cu-30 at.% Ni droplets solidified at selected undercoolings. F. GAERTNER and A. F. NORMAN (Cambridge Univ., UK); K. ECKLER (DLR Inst. fuer Raumsimulation, Cologne, Germany); A. L. GREER (Cambridge Univ., UK); and D. M. HERLACH (DLR Inst. fuer Raumsimulation, Cologne, Germany). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 29–36. 15 Refs.

For Cu–Ni alloy droplets processed by containerless solidification under levitation, the crystallographic texture correlates strongly with the microstructure seen in optical metallography and with the undercooling at which solidification started. The variation of texture is useful in understanding the development of the microstructure, in particular whether it is dendritic or grain-refined. Texture measurements can be used to estimate the maximum undercooling of a droplet when temperature measurement is not possible. (Author)

A96-44724 Influence of melt undercooling on the microstructure of Fe–Ni droplets produced in the Cambridge 6.5 m drop-tube. A. F. NORMAN, F. GAERTNER, and A. L. GREER (Cambridge Univ., UK). *Materials Science Forum* (ISSN 0255-5476), Vols. 215, 216, 1996, pp. 21–28. 20 Refs.

Dilute Fe–Ni alloys have been processed by containerless solidification in a drop-tube, and the resulting microstructures have been characterized mainly by optical metallography. For these alloys a competition exists between primary solidification to the equilibrium bcc α(Fe) phase and of the metastable fcc γ(Fe(Ni)) phase. For all droplets with compositions not more than 5 at.% Ni, the primary solidification phase is fcc γ(Fe(Ni)). With less than 5 at.% Ni the γ(Fe(Ni)) transforms on solid state cooling to the low temperature bcc α(Fe) form giving a Widmanstaetten morphology. With 5 at.% Ni, however, the final microstructure depends on the droplet size. For large droplets (greater than 600μ) the microstructure transforms to bcc α(Fe). In the small droplets (less than 200μ) the transformation is suppressed, resulting in a retained γ(Fe(Ni)) microstructure. For 10 at.% Ni, the microstructure consists of the metastable α(Fe) phase which is in agreement with the literature. For additions of 30 at.% Ni it is not possible to reach the metastable bcc liquidus so the equilibrium γ(Fe(Ni)) phase forms from the melt. (Author)

A96-37853 Simulation of molecular and crystal structures of mesogenic siloxane monomers and polymers. T. V. TIMOFEEVA (New Mexico Highlands Univ., Las Vegas); E. E. BODA (Sheffield Univ., UK); and K. Y. SUPONITSKY, K. A. LYSENKO, E. V. MATUHINA, and N. N. MAKAROVA (Russian Academy of Sciences, Moscow, Russia). *Space processing of materials; Proceedings of the Conference*, Denver, CO, 1996 (A96-37836 10-29), Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 2809), Bellingham, WA, 1996, pp. 166–175. 17 Refs.

A review of structural investigations of polymer cyclolinear organosiloxanes and monomer hydroxy derivatives of organosiloxanes, which form thermotropic liquid crystalline phases, is presented. To investigate the structure of these compounds, X-ray diffraction of solid crystalline and liquid crystalline samples have been done as well as spectroscopic investigations and molecular modeling. Molecular modeling based on the obtained earlier results on hydroxyorganosiloxanes gave us the possibility of predicting the existence of the same phase for the hydroxycarbosilanes that were synthesized and described in present work. The molecular modeling of cyclolinear organosiloxanes allowed us to describe their structure at the atomic level. (Author)

A96-15445 FHTS active thermal control analyser—Further improvements and validation. J. H. STRUTT, M. K. PATEL, and C. J. KIRTLEY (European Gas Turbines, Ltd., Whetstone, UK) and A. M. DAVIDSON (ESTEC, Noordwijk, Netherlands). *SAE 25th International Conference on Environmental Systems*, San Diego, CA, 1995, p. 11 (SAE Paper 951727). 11 Refs.

The second major upgrade to the Fluid Heat Transport System (FHTS) extension of the ESATAN thermal analyzer culminated in significant improvements and extensions to its two-phase capabilities. The third upgrade is nearing conclusion, the emphasis of this work centering around the improvement of the Graphical User Interface and the validation of the numerical algorithms employed. An interactive environment for the creation of ESATAN thermal models has been developed, easing both creation and visualization of the model hierarchy. To consolidate this facility the current FHTS Graphical User Interface has now been incorporated within the framework of this tool. This product is aimed at both new and experienced users and will allow the thermal engineer to concentrate more upon the thermal modeling aspects as opposed to the idiosyncrasies of the software tool. In 1994, a two-phase experimental capillary-pumped loop was flown on the Space Shuttle. From this mission a wealth of data is now available at component and system level for the engineer and scientist alike to extend their knowledge of two-phase flow phenomena in a microgravity environment. A validation program has been defined for FHTS using this data and preliminary results from the work are presented. (Author)

A96-11378 Crystallisation of α-crustacyanin, the lobster carapace astaxanthin-protein—Results from EURECA. P. F. ZAGALSKY (London Univ., UK) and C. E. WRIGHT and M. PARSONS (Leeds Univ., UK). *Advances in Space Research* (ISSN 0273-1177), Vol. 16, No. 8, 1995, pp. 91–94. 5 Refs.

Crystallization of α-crustacyanin, the lobster carapace astaxanthin-protein, was attempted under microgravity conditions in EURECA satellite using liquid–liquid diffusion with polyethyleneglycol (PEG) as precipitant; in a second reaction chamber phenol and dioxan were used as additives to prevent composite crystal growth. Crystals of α-crustacyanin grown under microgravity from PEG were larger than those grown terrestrially in the same apparatus under otherwise identical conditions. On retrieval, the crystals from PEG were shown to be composite and gave a powder diffraction pattern. The second reaction chamber showed leakage on retrieval and had also been subjected to rapid temperature variation during flight. Crystal fragments were nevertheless recovered but showed a powder diffraction pattern. It is concluded, certainly for liquid–liquid diffusion using PEG alone, that, for crustacyanin, although microgravity conditions resulted in an increase in dimensions of crystals, a measurable improvement in molecular ordering was not achieved. (Author)

A96-10125 Recent developments in phase-field models of solidification. A. A. WHEELER and N. A. AHMAD (Bristol Univ., UK) and W. J. BOETTINGER, R. J. BRAUN, G. B. MCFADDEN, and B. T. MURRAY (NIST, Gaithersburg, MD). *Advances in Space Research* (ISSN 0273-1177), Vol. 16, No. 7, 1995, pp. 163–172. 46 Refs.

In this paper we review the current state-of-the-art in the modeling of solidification by phase-field models. We briefly review the phase-field formulation of the solidification of a pure material and discuss how important physical effects, such as surface energy anisotropy, may be included. We discuss numerical solutions of the phase-field equations, with particular reference to the computation of dendrites. Finally, we describe recent successful attempts to extend the phase-field methodology to alloys. (Author)

N94-10071 The formation and breakage of liquid bridges under microgravity. J. F. PADDAY. *Proceedings of the 8th ESA European Symposium on Materials and Fluid Sciences in Microgravity*, Vol. 1 pp. 41–49 (SEE N94-10070 01-29).

The formation and breakage of liquid bridges under microgravity was analyzed experimentally from data obtained in parabolic flight, and it is shown that all such formation and breakages take place in at least two stages. With respect to breakage, the first stage, the bifurcation process, is shown to be slow and is driven slowly by diminution in surface free energy. The energy is, however, sufficiently large to increase the capillary pressure inside the bridge. The second stage may follow one of two paths depending on the capillary number of the liquid. At low capillary number, the neck of the bridge forms a rod of liquid which then breaks at each end to form a satellite drop, while the two liquid caps recoil under inertial forces. At high capillary number, the rod diameter decreases successively until it becomes threadlike and finally microscopic. Under these conditions no visible satellite drop is formed and no recoil occurs. Some experiments were performed which followed the merging of two spherical caps of liquid to form a stable unified zone. The process of merging is shown to require a small capillary pressure to bring the surface molecules into contact. Thereafter, the equilibrium shape is reached only after minimum area is reached. Again, liquids with high capillary number reach equilibrium quiescently whereas those with a low capillary number undergo traumatic union. When the two caps are composed of immiscible liquids the merging process is not as traumatic but is greatly slowed down as the new liquid–liquid interface is generated. The breakage follows the same pattern as with a single liquid, but the liquid of lowest surface tension is the phase in which breakage occurs. (ESA)