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... and Bad Nauheim (FRG)

A symposium on the structure and microstructure of high-temperature superconductors was held on April 21–22, 1988, in Bad Nauheim, Federal Republic of Germany. The aim of this comprehensive two-day symposium, organized by the Deutsche Gesellschaft für Metallkunde and chaired by *H. C. Freyhardt*, Göttingen, was to assemble an interdisciplinary group of scientists (physicists, chemists, crystallographers and materials scientists) and provide a forum for discussions devoted to the structure, microstructure, preparation and shaping, and applications of ceramic high-temperature superconductors (HTSCs). Leading scientists from Europe, the United States and Japan were invited to summarize the achievements in the field and to provide an evaluation of recent progress and unresolved problems.

The following lectures were presented: Structural aspects of mixed valence copper oxides and their relationships with superconductivity (*Raveau*, France)/Oxygen stoichiometry in pure and 3d-metal-doped $YBa_2Cu_3O_{7\pm y}$ (*Greene*, USA)/Structural aspects of the new Bi and Tl based high-T_c superconductors (*Batlogg*, USA)/Physical properties of high-T_c superconductors (*Steglich*, FRG)/On the microstructure of high-T_c superconductors (*Heeger*, FRG)/High-resolution transmission electron microscopy; principles and results on $YBa_2Cu_3O_{7-x}$ (*Gruehn*, FRG)/Phase diagrams of non-stoichiometric superconducting oxides (*Hauck*, FRG)/Crystal growth of high-T_c superconductors (*Hosoya*, Japan)/Bulk materials, shaping and prospects for applications (*Krauth*, FRG)/Application of high-T_c thin films in microelectronics (*Rogalla*, Netherlands).

In addition to the ten review talks, the latest results were presented on about 50 posters which were discussed in two plenary sessions. While the structure and properties of HTSCs were at the center of numerous discussions during the first day, the interest on the second day focused on "the real problems", as *H. E. Hoenig* from Siemens put it, namely preparation, shaping and applications. Controversies concerning the structure of the Bi-based superconductors do still exist, as a very lively discussion at the end of the first day showed.

The key quantity for HTSC applications in energy technology and superconducting electronics is the critical current density J_C. Based on magnetization curves of sintered, polycrystalline ceramic superconductors, the critical current density within a single grain was estimated to be of the order of 10^6 Acm^{-2} at $T=4.2$ K. The reason for the much lower J_C in sintered samples—typically 100–1000 Acm^{-2}—is considered to be the *weak links* between the grains in these materials. Defects such as voids, cracks and micro-cracks, second phase, including grain-boundary segregations and oxygen deficiency were also listed as reasons for the degradations of the transport properties. While the critical current densities in sintered HTSC materials are presently too low for most applilcations, J_C values in thin films prepared by a variety of methods are much more promising. However, not only the current carrying capability but also the film morphology must be considered; applications in superconducting electronics require very flat film surfaces for multiple stacked layers. The surface of epitaxially grown films or films made by laser ablation is too rough for applications in superconducting electronics. A further problem associated with thin films of HTSCs is the substrate-film compatibility. Evidence for Mg-Cu interdiffusion of $YBa_2Cu_3O_7$ films on MgO substrates was shown, and the necessity for passivation layers, e.g. silicon nitride on silicon substrates, was suggested. Various methods for the structuring of films were discussed, mostly for the fabrication of Josephson junctions. Because of the small coherence lengths in the HTSC materials, these Josephson junctions are difficult to prepare. Thus superconducting chip-interconnects seem much more likely applications at present than on-chip application of Josephson switching elements.

At this symposium the necessity of an interdisciplinary approach to the problem of high-T_C superconductivity became clear once again. Exact determination of the physical properties of these materials requires samples of higher phase purity and, of course, larger single crystals. Thorough investigations of preparation and shaping of these interesting substances are an important prerequisite for technological applications.

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