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Editorial Note

Nuclear materials are studied for their specific applications under extreme temperature, pressure and irradiation conditions. These materials act as barriers or as structural materials and their properties are investigated with an emphasis on their mechanical performance, durability, plasticity and stability. Symposium N included sessions dealing with materials ranging from structural components of fusion systems, advanced spallation or fission units, structural parts of thermal or fast reactors, fuels and waste forms. Macroscopic properties such as thermodynamical, thermophysical and mechanical as well as microstructural analysis of these materials were discussed for example, comparing properties before and after irradiation.

The *component* materials for advanced fusion systems were first considered. The temperature as well as the energy and flux of particles are very high. This double session chaired by A. Serra (Uni Cataloña) and A. Möslang (FZK), as well as by N. Baluc (EPFL) and B.Wirth (Uni Berkeley) was connected with research activities on structural materials.

The liquid and solid *target* for advanced units such as spallation sources or accelerator driven systems were treated in the second session chaired by M.J. Caturla (Uni Alicante) and J. Lettry (CERN).

The *component* materials for advanced fission reactors were considered in the third session. In these systems, the temperature as well as the energy and flux of particles are also very high. This session chaired by U. Ehrnstén (VTT) and L. DeBarberis (JRC) concerned research activities and R&D for high temperature gas reactors.

The *structural* materials of thermal reactors such as cladding, assembly components, reactor internals and vessel or piping were treated in a specific session chaired by M. McGrath (HRP, Halden) and V. Borodin (Kurchatov Institute).

The *fuel* materials include advanced oxides, nitrides, carbides or metals in homogeneous form or as composites such as cercer, cermet or metmet that can be used either as fuel or as target for transmutation. These topics were treated in a session chaired by Ch. Guéneau (CEA) and J.R. Kennedy (INL).

The *waste* form materials must be recognised for their durability, low solubility or leaching rate in environmental conditions over geological time scales. This double session was chaired by C. Ferry (CEA) and M. Petters (ANL), as well as by B. Fourest (Uni Orsay) and St. Kalmykov (Uni Moscow).

The poster session, which dealt with the aspects described above, displayed 30 posters forming a nice panorama through the topicS explored in the symposium. The session was chaired by V. Oversby (VOM) and K.Czerwinski (Uni Las Vegas) who organised a vote for the best poster award.

The symposium was sponsored by the Department of Physics and Chemistry (DEN/DPC) of CEA and with the cooperation program of the IAEA. The student awards were given to C. Tamain (Uni Orsay) for her work on behaviour of thorium phosphate after irradiation and to D. Terentyev (ULB) for his work on the characterisation of dislocation loops in ferritic steels. The best poster award was given to B. Kienzler (INE, FZK) for his work on the waste form concepts for future investigations. The symposium was also represented in the EMRS technical exhibition by Extremat, SETARAM and EFDA.

From the Symposium it emerges that mathematical modelling of materials behaviour is a valuable tool that is required for the specific development of the next generation of nuclear and fusion technology. Significant

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contributions to this field by experimentally validating predictions from models that simulate the dynamics of dislocations in the presence of radiation-induced defects were presented.

High energy irradiation is inherently a multiscale phenomenon that drives materials into a non-equilibrium state. One of the macroscopic consequences is often a severe loss of ductility even for the most advanced alloys available today. Although the related microstructural changes in irradiated materials are well documented, the atomistic processes responsible for them are by far not fully understood.

But irradiation degradation is not only an issue in advanced fission or fusion reactors. The Spallation Neutron Source (SNS, ORNL) providing the most intense pulsed neutron beams in the world for scientific research and industrial development, also needs structural materials resistant to high-energy protons and neutrons.

Important R&D studies on fuel were presented, here again with a versatile balance between modelling and experimental work. The development of safe and ecological fuel remains a key research focus together with the incineration of minor actinides.

The effects of radiation damage in solids are an important issue for the interim storage and geological disposal of spent nuclear fuel and the materials used for its encapsulation. The sustainability and public acceptance of nuclear energy for the coming decades is directly related to the solutions that will be proposed at the back end of the fuel cycle. As a representative aspect on the current research activities, results were presented on the capacity of glasses to incorporate higher fission products contents and minor actinides while conserving the same confinement properties. Results were also presented concerning the capacity of the different materials to undergo long-term irradiation and the different interactions occurring in geological disposal between the waste package and the environmental materials.

In all cases, irradiations with accelerators guide the investigator in choosing the optimal components prior to irradiation in the reactor or with a radionuclide. The challenge in this century will be to work with reliable or inert material that makes their use safer with respect to economical and ecological goals, making their utilisation more sustainable for nuclear systems.

The complex issues involving the design and development of next-generation nuclear and fusion reactors require a synergy in comparing experimental data with simulations based on a multi-scale approach and new strategies are required to successfully tackle the materials problems arising, ranging from irradiation damage in the reactor to the storage of spent nuclear fuel.

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