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Preface

Developing materials for energy applications is a multidisciplinary field, ranging from the conception and synthesis of new materials, their characterization as well as their assembling to highly performing devices for energy storage or transformation.

The interest of neutrons in this research area is mainly based on their particular physical properties:

- Neutrons used for the characterization of the materials possess wavelengths and energies comparable to interatomic distances and related lattice dynamics. Thus, neutron scattering enables to access simultaneously to structure and dynamics of many kinds of materials.
- Having no electric charge, neutrons can penetrate the material without being absorbed significantly, which allows a non-destructive characterization of constraints, textures etc., even on large volumes of materials.
- The possibility to easily vary the contrast of a single element using its different isotopes renders the neutron to be an irreplaceable tool in chemistry, solid state physics, in biology and soft matter.
- The fact that the neutron is endowed with a magnetic moment allows it to interact with any atom carrying a magnetic moment. This enables to directly characterize the magnetic behaviour of materials on a microscopic scale.

All the characteristics mentioned above place neutron scattering as a unique tool for many areas in fundamental research as well as industrial R&D. An efficient use of "neutron scattering" requires, however, not only a basic understanding of the different mechanisms of the interactions between neutrons and matter, but equally of the highly specific design and use of neutron spectrometers and diffractometers. For these reasons, access to neutrons is often limited, if not reserved to specialists only, which naturally hinders a wider use by researchers unfamiliar with this area.

In order to fill this gap, the school "Neutrons and Materials for Energy" was conceived especially to teach neutron scattering to non-specialists and was, in particular, adapted to explain the use of neutrons for the characterization of materials for energy storage and transformation.

As "neutron scattering" continues to play a key role in the development and characterization of new materials, considerable efforts were undertaken in the United States and Japan, to build up two new powerful neutron spallation sources. Even more important the new European neutron spallation source (ESS), the construction of which is under way, is expected to deliver a neutron flux exceeding that of current sources by orders of magnitude. It is obvious that an effective and intelligent use of existing and future neutron sources requires a basic knowledge of neutron scattering and instrumentation.

Following a well-established tradition, the French Neutron Society (Société Française de Neutronique, SFN) annual meeting, the 21èmes Journées de la Diffusion Neutronique (JDN21), was preceded by a thematic school organized with the financial support of the CNRS, of the two neutron research centers, the Institut Laue-Langevin and the Laboratoire Léon Brillouin, the University of Montpellier 2, the CEA and the Region Languedoc Roussillon. The school was dedicated to "Neutrons and Materials for Energy", and focused on various applications of neutron scattering for the study of "high-tech" materials, especially in the energy sector. The development of new materials for energy is one of the major challenges of this century and is based largely on a thorough understanding of the

origins of multi-scale properties. Neutron scattering, with their ability to probe the matter from the atomic scale to the macroscopic scale, contributes significantly to this objective. This school was open to all researchers, from academic centres of research but also from development and research industry laboratories, who wish to learn and use the capabilities of neutrons to contribute to knowledge in the field of materials for energy production and energy storage.

The school was held in Sète in the South of France, from 21th to 25th June 2013. About 50 participants enjoyed this exceptional site at the edge of Mediterranean Sea, where the "languedociennes" traditions and natural beauties mingle. During the 4 days school lectures on the various techniques of neutron scattering for the study of energy materials were alternated with sessions of tutorials and practicals. Opening seminars concerned the global needs for "Materials for energy" by Daniel Marinha (CREE, who was unfortunately unable to provide a manuscript) followed by a general introduction on "Neutrons and materials for energy" as well as "Neutron – Condensed Matter Interaction" (W. Petry, TUM). Further lectures concerned diffraction (T. Hansen, ILL), SANS and neutron-reflectometry (F. Cousin, LLB), imaging (E. Lehmann, PSI) and inelastic neutron scattering (A. Piovano, who accepted to provide the manuscript M. Koza, ILL, was unable to deliver) completed by emerging methods in crystallography, like Pair Distribution Function (P. Bordet, Inst. Néel and M. Brunelli, ESRF). Courses were followed by exercise sessions where the theoretical concepts were put into practice and deepened on concrete examples. Scientific lectures illustrated the necessity of neutron scattering for the study of nuclear materials (J.L. Bechade and Y. de Carlan, CEA) as well as for the elaboration of new compounds. This book gathers most of the lectures given during the school "Neutrons and Energy Materials", organized under the patronage of the Société Française de la Neutronique.

We hope that these chapters will contribute to help "non-specialists" researchers to access more easily to different neutron scattering techniques, but also to provide a basis for teachers for the preparation of their lectures.

Last not least, we take the opportunity to thank all the speakers and participants, as well as all sponsors, for their contributions and making this neutron school a success.

Monica Ceretti and Werner Paulus (ICGM Montpellier),
Marie-Hélène Mathon (LLB),
Clemens Ritter (ILL)