Neutron powder diffraction and “green” energy challenges
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The rapid technology progress, whose consequences we can see and use in the every day life, is directly proportional to the amount of energy available to meet the growing demands of individuals and industries throughout the world. The major part of available energy is received from non-renewable sources and it is usually harmful to the environment upon burning. Thus, in the world energy production fossil fuels, like natural gas and crude oil, along with nuclear consist about 80% of the worldwide amount, which slowly drives the world towards the resources and ecology crisis and a single way to overcome the crisis safely is to find alternatives. This is the primary goal for modern science and, therefore, many research groups from science and industry are engaged into alternative energy research.

Nowadays the most of “green” (non-mechanical) energy applications are based anyhow on the light elements (hydrogen, lithium, oxygen), whose studies by conventional laboratory methods are quite challenging, i.e. desired detailing and accuracy can be hardly achieved. In this sense neutron scattering due to its unique features is an excellent tool, often having no alternative, when characterization of complex systems containing light elements, especially in the presence of heavy ones, is under discussion. The high penetration depths of thermal neutrons along with their low energy suit perfectly for non-destructive in-situ and in-operando studies of different kinds; the capability to localize light elements/isotopes (e.g. hydrogen, lithium) and to distinguish neighbouring elements from Periodic Table provides excellent phase contrast; the neutron scattering lengths not dependent on momentum transfer give accurate structure factors leading to precise bond-length and Debye-Waller factor analysis along with exact determination of diffusion pathways. On the other hand the high penetration depth of thermal neutrons along with the presence of either nearly neutron-transparent or nearly fully neutron-absorbing materials make the use of complicated sample environment (temperature, pressure, electric and magnetic fields, gas atmosphere, tension etc.) and its effect on the experimental results much simpler to account for.

In the current contribution a review of “green” energy-related scientific activities performed at the high-resolution neutron powder diffractometer SPODI at research reactor FRM-II will be presented with partial concern on modern thermoelectrics, materials for hydrogen storage, fast oxygen conductors for solid oxide fuel cells applications, electrode materials for enhanced lithium transport, Li-ion batteries etc.