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The Use of Thermal Neutron Beams at Medium Power Reactor LWR-15 in Řež for Competetive Neutron Scattering Experiments

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Neutron Physics Laboratory of NPI ASCR, v.v.i. operates several neutron instruments installed at the medium power reactor LWR-15 having a nominal thermal power of 10 MW and a neutron flux rate of about 1x1014 n.cm-2s-1 in the core.
Research investigations at an international level are carried out using dedicated instruments. They are
• Determination of internal stresses in polycrystalline materials by neutron diffraction. This instrument is used especially for thermo-mechanical testing of materials, i.e. to study the deformation and transformation mechanisms of modern types of newly developed materials. Then, neutron diffraction performed in situ upon external loads, brings a wide range of valuable structural and sub-structural parameters of the studied material which can be easily correlated with parameters of the external loads.
• Microstructure, porosity and inhomogeneity studies by a high Q-resolution small-angle neutron scattering (SANS). The SANS instrument is mainly suited for investigation of structural or compositional inhomogeneities in materials in the size range 0.05÷2 micrometer, mainly porous materials and large precipitates in alloys.
• Structure studies of polycrystalline materials by medium resolution powder diffraction and structure behaviour under termo-mechanical load. The powder diffractometer is mainly used to the study of the crystalline and/or magnetic structure of the powder or polycrystalline samples. Due to the several sample environments including vacuum and light furnace, close cycle cryostat, Euler goniometer, deformation rig and automatic sample exchanger, this instrument is an universal tool in the field of powder diffractometry.
• Surface studies of technologically interesting materials by means of neutron depth profiling (NDP). The NDP technique exploits nuclear reactions of neutrons with nuclei to analyze concentrations or concentration profiles of elements in solids just under the surface.
• Neutron activation analysis (NAA) using vertical irradiation channels. Using both short-time (10 s - 3 min.) and long-time (several hours - several days) irradiations, information about concentrations of up to 65 elements can be obtained, in many cases by non-destructive, so-called instrumental neutron activation analysis (INAA). The detection limits range from μg.kg-1 up to tens of percent, depending on the particular element and bulk matrix composition.
• The development of high resolution and high efficient monochromators and analysers on the basis of Bragg diffraction optics using cylindrically bent perfect crystals.
• Education and training programmes.
NPI has also capability for Monte Carlo simulations by using a widely recognized (at the European level) RESTRAX software package for estimation of characteristic properties of designed performance of neutron scattering devices and their optimization. The unique of the RESTRAX package for neutron ray tracing consists in its possibility of implementing the neutron optical elements (e.g. curved crystals, flat or curved mirrors and supermirrors, any type of collimators etc.). In all the investigations, highly recognized results of an international significance have been obtained during the last decade. Recently, substantial work has been done on the Engineering diffractometer BEER which will be installed at ESS neutron source. A high standard of neutron research in the Neutron Physics Laboratory of NPI has been recognized by participation of the laboratory in EU-NMI3 ACCESS projects as well as in the next one EU-SINE2020 starting in 2016. The access to the mentioned experimental techniques for external users is for the future ensured by a Czech project CANAM (http://canam.ujf.cas.cz/index.php?option=com_flexicontent&view=items&id=142&lang=en).
Examples of some unique experimental results obtained on the NPI instruments installed at the reactor LWR-15 will be presented.

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