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EXPERIMENTAL NEEDS FOR NEUTRON SCATTERING METHODS IN THE CHARACTERIZATION OF NUCLEAR MATERIALS AND COMPONENTS

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This contribution will discuss some experimental needs for efficient utilization of neutron techniques to characterize nuclear materials, more specifically small-angle neutron scattering (SANS) and neutron diffraction. SANS provides fundamental information on micro-structural evolution under irradiation in structural materials; neutron diffraction is indispensable for stress measurements in nuclear welds and for monitoring crystallographic phase changes under thermo-mechanical treatments or irradiation. The utilization of these techniques in such complex fields is challenging, both concerning instrument development and needed flux. Namely, concerning SANS some of the main requirements can be summarized as follows: efficient handling of hot neutron irradiated samples (10-20 mSv/h), capability to investigate also miniaturized irradiated samples, developing polarized SANS for deep metallurgical characterization of magnetic steels, developing GISANS/reflectometry for thin ion irradiated samples. High spatial resolution is first of all needed for stress measurements in nuclear welds, since the most critical stress gradients, next to the weld or in the heat affected zones, may often develop over distances smaller than 1 mm; adequate neutron flux is also mandatory for obtaining bulk averaged results and comparing both with mechanical testing and with numerical predictions. These items will be discussed making reference to recent experimental work carried out on fusion reactor materials.

Recent references:
R. Coppola, M. Klimenkov, A. Möslang, R. Lindau, M. Rieth, M. Valli, Micro-structural effects of irradiation temperature and helium content in neutron irradiated B-alloyed Eurofer97-1, Nucl. Mat. En. 17 (2018) 40-47
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R. Coppola, F. Crescenzi, W. Gan, M. Hofmann, M. Li, E. Visca, J.-H. You, Neutron diffraction measurement of residual stresses in an ITER-like tungsten-monoblock type plasma-facing component, Fus. Eng. &Des. (2019) in print

Poster back-up

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