

Investigations of the precipitation microstructure in the alloys, hard metal composites, and powders using SANS

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In this study, we present the microstructure of various materials, obtained by using small-angle neutron scattering (SANS) in combination with different complementary scattering techniques. SANS resolution enables the investigation of inhomogeneities or precipitates in mesoscopic range with excellent statistics through sample bulk, moreover, it can be applied in-situ. For an example of precipitation of ω and α phases in the β matrix of the metastable β titanium alloy (Ti with 15 wt.% Mo), we show how SANS data can describe temperature resolved evolution of these phases at various heating rates [1]. Small-angle scattering, in this example, allow to overcome detection limits of the neutron diffraction due to the small size of the nanoparticles, and, it helped to demonstrate the coexistence of all three phases at about 550 °C, and to explain the abnormal behaviour of resistivity during constant rate heating.

SANS is an effective tool for the investigation materials containing heavy elements such as W and Co. In vanadium (V)-doped tungsten carbide (WC)-Co composite material system, in-situ and ex-situ SANS and ultra-small-angle neutron scattering (USANS) experiments helped us to delineate how additions of V affect the nano- and microstructure during sintering and result in smaller WC grains [2, 3]. Whereas SANS quantified the nano-scale interfacial layers responsible of grain coarsening inhibition, USANS was applied to study microstructural refinement.

SANS was also applied for the investigation of the Sc-doped TiO₂ anatase as material for photocatalysis. Growth of Sc precipitations was observed with increasing aging temperature (Fig. 1) due to its expelling from anatase crystallites. It was proved by SANS, neutron diffraction and electron microscopy measurements that whole scandium content at 800 °C was driven out of grains and formed particles at TiO₂ grain boundaries.

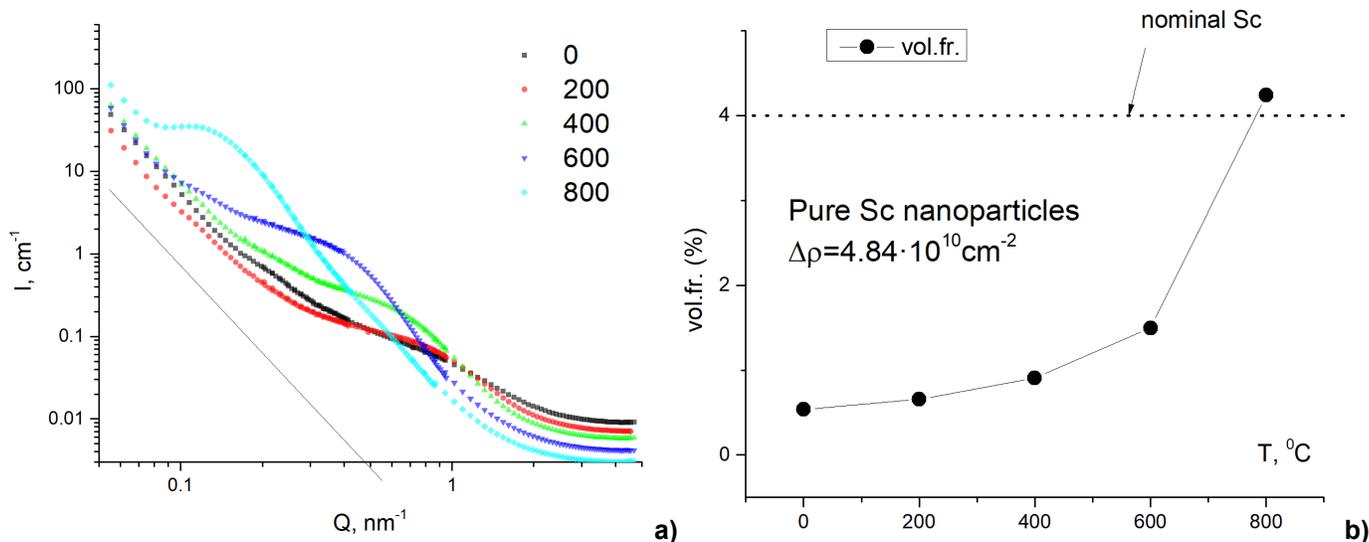


Figure 1. SANS data of Sc-doped TiO₂ (a) and fitted from SANS volume fraction of Sc precipitates (b)

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