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Microstructure of engineering materials studied by SANS

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Microstructure of engineering alloys is strongly connected with their mechanical properties such as hardness or ductility. Usually conventional methods of electronic microscopy are used for assessing morphological characteristics of the precipitates. However, in some cases the small-angle neutron scattering (SANS) technique can be more efficient due to unique properties of neutrons such as law absorption (it allows to study thick samples) and presence of magnetic moment (for better detection of magnetic microstructures). Here, we would like to show few examples of such cases.
Medium carbon spring steel was studied by influence of copper on precipitations during aging. It was found that alloying by copper scientifically improves material characteristics (increases yield stress, better corrosion resistance, "self-healing"of ultrafine cracks). Magnetic SANS (MSANS) was used for accurate characterization of this nanosized copper particles nucleated by tempering at 400-500 ℃. In this case MSANS was very effective and in perspective it can be used for in-situ study of Co precipitation kinetics in similar alloys.
Another case –in-situ and ex-situ SANS study of sintering process in composite tungsten (W) grains in cobalt (Co) binder. In vanadium (V)-doped tungsten carbide (WC)-Co composite material system, both in-situ and ex-situ SANS and ultra-small-angle neutron scattering (USANS) experiments helped to explain how additions of V affect the nano- and microstructure during sintering and result in smaller WC grains. Whereas, SANS quantified the nano-scale interfacial layers responsible of grain coarsening inhibition, USANS was applied to study microstructural refinement.

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