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Advanced alloys and steels microstructure characterization by analytical high resolution scanning transmission electron microscopy

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Development of new materials for specific applications requires the fundamental understanding of the atomic scale effects which drives the micro- and nano-structure particularities. In order to understand, circumvent or exploit these effects advanced characterization methods for the whole range of nano-scaled precipitates are needed. This paper presents new developed and correlative microscopic methods for the investigation of different material types ranging from Mg and Al based alloys to chromium rich steels. Energy filtered transmission electron microscopy (EFTEM) and scanning TEM (STEM) provides insight into the material's crystallography and chemistry quantitatively and at atomic resolution. STEM mode acquisition of 2 or 3D data sets of high angular annular dark field images (HAADF) at atomic resolution and both X-ray (EDX) and electron energy loss spectrometry (EELS) spectrum images proved to be very useful for the localization and identification of different modifying elements with very low concentration (Sr, Yb, Ag in Al-alloys and Ca in Mg-alloys). We observed that Sr atoms produce twinning only if they take interstitial positions in the eutectic Si. This effect is directly linked to the modification of the eutectic Si from a plate like to a fibrous morphology in Al-Si alloys. Yb on the other hand (in Al-Si alloys) cannot take such positions and thus they only form atomic chains inside the eutectic Si phase with no consequences on twinning. However, they segregate at the interface with matrix producing a refinement of the eutectic Si. In case of silver added to Al-Cu alloys, 2-5 atomic layers at the surface of the θ and precursors of Q phases have been found. Additionally, the nucleation and evolution of some precipitates in Cr steels during heat and creep treatment due to pipe- and substitutional diffusion could also be studied.

Biography

Mihaela Albu is an expert in "Analytical high resolution transmission electron microscopy of alloys, steels, composites, porous materials and nanoparticles". Her research interest includes "The understanding of fundamental effects induced by impurities in diverse alloys and nucleation of secondary phases in tempered and creep tested alloys and steels".

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