Microstructure analysis of tungsten materials produced by different fabrication routes

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Microstructural and analytical investigation using transmission electron microscope (TEM)

Investigations are carried out on two different production batches of tungsten composite half-finished product with 1% lanthanum oxide (W-1% La₂O₃). The grain sizes in both materials measured by TEM and HAADF methods vary from 0.5 to 5μm (Sample 1) and from 0.5 to 8μm (Sample 2). Grains mostly show an elongated shape. Partial dislocations are existing inside grains. Holes in the samples are results of the electro-chemical preparation with the TENUPOL 5 system. Analytical TEM investigations by 2D EDX mappings show lanthanum in separated lanthanum oxide particles only. Elementary lanthanum could not be detected along grain boundaries or inside tungsten grains.

Microstructural investigation using a focused ion beam (FIB) system

Questions about the shape and variation of the lanthanum oxide particles in tungsten are answered clearly by 3D visualization. Slices have been produced using a FIB “Slice & View” technique and were processed in Amira® for surface rendering after precise alignment using fixed crosses. Visualized oxide dispersion particles in investigated half-finished products of W-1% La₂O₃ show a different structure, depending on different fabrication routes: Sample 1 (rolled rod) - nearly a spicular structure and Sample 2 (swagged rod) - platelet shaped particles.

Sample 1 - SEM image and 3D visualization of lanthanum oxide particles with a needle structure in a tungsten matrix, sliced area of about 60x35x50μm. In this refractory alloy lanthanum oxide particles have nearly a spicular structure and 3D visualization clearly indicates a considerable fraction of the aligned particles longer than 20μm.

Sample 2 - SEM image and 3D visualization of lanthanum oxide particles with sheet-like structure in a tungsten matrix, sliced area of about 20x10x15μm. The difference in the particle structure of both samples results from significant deviations of the production process.