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On the implication of solute contents and grain boundaries on the Hall-Petch relationship of nanocrystalline Ni-W alloys

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Abstract

Nano-crystalline nickel-tungsten alloys are investigated in order to provide evidence of the contribution of the solute content (light elements and tungsten) and grain-boundaries on hardness. For this purpose, Ni-W alloys were elaborated by electrodeposition in an additive free citrate ammonium bath. The variation of electrodeposition conditions leads to W contents up to 18 at. %, with a broad range of grain sizes (5 to 650 nm). The incorporation of light elements (H, O, C, N) depends on the deposition applied conditions and a progressive modification of the texture is observed with the following sequence: {110}, NT (Non Textured) and {111} textures. We show that the Hall-Petch relationship for these alloys is influenced by the presence of light elements, the nature of the crystallographic texture and the grain boundaries character. The dependence of grain size on flow stress is a direct consequence of the solute content (solute strengthening) and the evolution of the internal stresses with grain size. To explain the experimental data, two competing physical mechanisms are suggested: grain boundary shearing and dislocation emission at grain boundary, which are affected by the nature of the grain boundary and the solute content.

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