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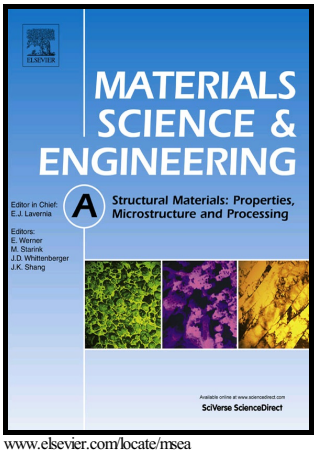

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High strength and high ductility in the Co–20Cr–15W–10Ni alloy having a bimodal grain structure achieved by static recrystallization

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Abstract

A bimodal grain structure consisting of fine grains (d ~ 1–2 μm) and coarse grains (d ~ 10–20 μm) was achieved in the biomedical Co–20Cr–15W–10Ni alloy via medium cold rolling (area reduction of 50%) followed by short-term annealing (15 min) at relatively low temperatures (950–1100 °C). The medium cold rolling induced a heterogeneous microstructure featuring the coexistence of severely deformed regions and weakly deformed domains. With short-term annealing at low temperatures, fine and coarse grains were preferentially recrystallized in severely deformed regions and weakly deformed domains, respectively, resulting a bimodal grain size distribution. During tension, dislocations were more rapidly generated in the fine grains, thus increasing the strain hardening, while they glided longer on the {111} planes in the coarse grains, contributing a high ductility. The combination of these two factors provided well-balanced strength–ductility behavior with an ultimate tensile strength of 1,278 MPa, a yield strength of 787 MPa, and an elongation to fracture of 53%, making the alloy suitable for surgical implant and stent applications where the strength and ductility are both important to ensure mechanical reliability in a human body.

Keywords: L-605; biomaterials; plasticity; annealing; strain hardening; tensile properties