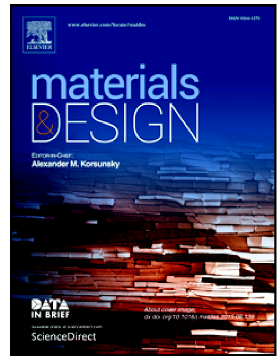

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Microstructural evolution, nanoprecipitation behavior and mechanical properties of selective laser melted high-performance grade 300 maraging steel

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Abstract: High-performance grade 300 maraging steels were fabricated by selective laser melting (SLM) and different heat treatments were applied for improving their mechanical properties. The microstructural evolutions, nanoprecipitation behavior and mechanical properties of the as-fabricated and heat-treated SLM parts were carefully characterized and analyzed. The evolutions of the massive submicron sized cellular and elongated acicular microstructures are illustrated and theoretically explained. Nanoprecipitates triggered by intrinsic heat treatment and amorphous phases in as-fabricated specimens are observed by TEM. High-resolution TEM (HRTEM) images of the age hardened specimens clearly exhibit massive nanosized needle-shaped nanoprecipitates Ni_3X (X=Ti, Al, Mo) and 50~60 nm sized spherical core-shell structural nanoparticles embeded in amorphous matrix. XRD analyses reveal austenite reversion and probable phase transformations during heat treatments. The hardness and tensile strength of the as-fabricated and age-treated SLM specimens absolutely meet the standard wrought requirements. Furthermore, the lost ductility after aging can be compensated by preposed solution treatments. Relationships between massive nanoprecipitates and dramatically improved mechanical performances of age hardened specimens are elaborately analysed and perfectly explained by Orowan mechanism. This study demonstrates that high-performance grade 300 maraging steels, which is comparable to the standard wrought levels, can be produced by SLM additive manufacturing.

Key words: Selective laser melting; Maraging steel; Precipitate; Age hardening; Microstructural evolution; Orowan mechanism.

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