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Evolution mechanism of Mo-rich, B2-NiAl, and Cu-rich particles under high temperature and its influence on thermal stability and thermal fatigue in a maraging hot work steel SDH88

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A novel maraging hot work steel designed for integrated die casting, SDH88, is developed to achieve a balance between ultimate tensile strength (UTS), yield strength (YS), and elongation by combining nanometer-scale precipitates of B2-NiAl, Cu-rich, and M2C carbide. Compared with H11 hot work steel, SDH88 steel exhibits an excellent hardenability and better tempering softening resistance (TSR, i.e., thermal stability). This means that SDH88 steel can avoid the deformation and cracking risk of traditional die casting mold during quenching and tempering process, as well as have a lower time cost. On the other hand, the TSR and thermal fatigue resistance are tested. The precipitation evolution of Mo-rich, B2-NiAl, and Cu-rich particles under 600℃ is systematically investigated, which is close to the service temperature. Compared with H11 steel, the fast rate of age hardening of SDH88 steel is attributed to the precipitation of NiAl nanoparticles. As the increasing of holding time under 600℃, the relative better TSR of SDH88 steel is related to the transformation of M2C and M6C to Laves phase. The results of thermal fatigue tests show that the thermal fatigue crack depth of SDH88 steel is smaller than that of H11 steel in the early stage of thermal fatigue. This is related to the higher tempering softening resistance of SDH88 steel, which can better resist the early thermal fatigue crack initiation. As the number of thermal fatigue cycles increases to 2000, the thermal fatigue properties of SDH88 steel are close to those of H11. Finally, this work aims at proposing a new approach for designing hot work die steel without quenching treatment during mold processing.

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