Current Progress of Innovative Manufacturing Technologies on ODS Steels

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Oxide dispersion strengthened (ODS) steel is one of the most promising candidates for structural materials of fusion blankets. However, scalable cost-effective manufacturing of ODS steel has been a major challenge for its application, as the traditional ball milling and powder consolidation route is of low capacity of production, poor reproducibility and high cost. Innovative manufacturing technologies suitable for mass production of ODS steels has been intensively investigated in past decades.

In this study, progress of innovative manufacturing technologies on ODS steels will be reviewed, and the focus will be on the precursor assisted casting technology (PACT) and wire arc additive manufacturing (WAAM) that show great potential for preparing large-size ODS steel by the liquid metal forming process. ODS steel exhibits good irradiation resistance and creep properties thanks to the high density (10^{23}~10^{24}/m^3) of nano-sized Y-containing oxide particles in the steel matrix. Obviously, the first priority of any potential manufacturing methods is to achieve uniform dispersion of nano-sized oxide particles. The difficulty lies in that both the Y and O solid solution content in the matrix should be hundreds of ppm or even higher according to the re-precipitation mechanism of oxide particle formation, which is far apart from their equilibrium state. Innovative manufacturing technologies aim to reduce the gap, and can be categorized into solid state process and liquid metal forming process routes. Innovative manufacturing technologies such as internal oxidation, oxide/liquid steel blending, Fe_2O_3 oxygen carrier casting method, gas atomization reaction synthesis (GARS) and friction-based processing, PACT and WAAM will be discussed. It is indicated that the simplicity, low cost, and size scalability of the liquid metal forming process provides a feasible method to prepare large-size ODS steel.

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