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Thermally processed austempered ductile iron -ADI

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Thermo-mechanical processing as a method of strength improvement of ductile irons (DI) recently attracts research and industrial interest. Thermo-mechanical processing refines the as-cast structures, closes up the internal shrinkage cavities and gas porosity and is able to reduce the segregations of alloying elements. Additionally, it increases the dimensional accuracy and improves surface finish of the products finally reducing the manufacturing costs. This work highlights the transformation kinetics, microstructure evolution, mechanical behaviour of thermo-mechanically processed ductile irons. In the framework of this study, ductile irons (DIs) with different aluminium, silicon, manganese and copper levels are investigated. The DIs subjected to different total values of true strain of 0, 0.3 and 0.5. Additionally, two types of matrices were produced, namely ausferritic and ausferritic-ferritic matrices. The introduction of ferrite to the matrix to produce dual matrix (DM) DI is accomplished by two different methods, which are: the isothermal holding in the inter-critical temperature range after austenitization and the direct heating to this temperature range. It is observed that increasing the aluminium widened the inter-critical region and shifted it to a higher temperature range. The former effect rendered the inter-critical annealing more controllable. The latter effect is also observed as a consequence of increasing the silicon level. Thus, increasing the aluminium- and silicon-levels in DI resulted in increasing the inter-critical annealing temperature range and consequently increasing in the carbon saturating the inter-critical austenite. This carbon increase substantially enhanced the strength and hardness of DI with dual matrix structure. The microstructure evolution and mechanical properties of the DI with DM are mainly governed by the chemistry of the inter-critical austenite. On the other hand, the manganese increase to 0.7 wt% yielded a reduced rate of ausferrite transformation simultaneously; significant higher volume percentage of untransformed austenite was retained on the expense of the strong ausferrite, which lowered the strength and ductility. Thus, manganese is not beneficial for the ausferritic and ausferritic-ferritic DI. The copper addition to the DI in a level of 0.8 wt% enhanced both of the graphite nodularity and the nodule count and resulted in improving the strength and ductility of the produced DI. The generated ferrite by isothermal holding in the inter-critical region after austenitization (ferrite is formed from austenite) is clustered around the graphite nodules, whereas that generated by heating and holding in the inter-critical region (austenite is formed from ferrite/pearlite) is well distributed in the matrix. The latter microstructure showed superior strength, ductility to the former one.

Biography

Adel Nofal is a Professor of Metal Casting and former President of Central Metallurgical R&D Institute. He is the Head of the World Foundry Organization (WFO) technical committee ADI. He is the Member of the European Cast Iron Group (ECIG) as one of two non European scientists worldwide. He has received State Merit Award of Advanced Technological Sciences (2010) and award of Scientific Excellence from the Egyptian Academy for Scientific and Research Technology (2002). He is the author of about 150 scientific publications and Chairman of The Egyptian International Symposium on Science and Processing of Cast Iron (SPCI-9) – Luxor – Egypt. He is the President of Egyptian Foundry Men Society.

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