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Austempered Compacted Graphite Irons: Influence of Austempering Temperature on Microstructure and Microscratch Behavior

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Abstract : This study investigates the effect of austempering temperature on microstructure and scratch behavior of the austempered heat-treated compacted graphite irons. The as-cast was used as base material for heat treatment practices. The samples were extracted from as-cast ferritic CGI pieces and were heat treated under austenitising temperature of 900°C for 60 minutes which followed by quenching in salt-bath at different austempering temperatures of 275°C, 325°C and 375°C. For all heat treatments, an austempering holding time of 30 minutes was selected for this study. Light optical microscope (LOM) and scanning electron microscope (SEM) and electron back scattered diffraction (EBSD) analysis confirmed the ausferritic matrix formed in all heat-treated samples. Microscratches were performed under the load of 200, 600 and 1000 mN using a spheroconical diamond indenter with a tip radius of 50 µm and induced cone angle 90° at a speed of 10 µm/s at room temperature ~25°C. An instrumented nanoindentation machine was used for performing nanoindentation hardness measurement and microscratch testing. Hardness measurements and scratch resistance showed a significant increase in Brinell, Vickers, and nanoindentation hardness values as well as microscratch resistance of the heat-treated samples compared to the as-cast ferritic sample. The increase in hardness and improvement in microscratch resistance are associated with the formation of the ausferrite matrix consisted of carbon-saturated retained austenite and acicular ferrite in austempered matrix. The maximum hardness was observed for samples austempered at 275°C which resulted in the formation of very fine acicular ferrite. In addition, nanohardness values showed a quite significant variation in the matrix due to the presence of acicular ferrite and carbon-saturated retained austenite. It was also observed that the increase of austempering temperature resulted in increase of volume of the carbon-saturated retained austenite and decrease of hardness values.

Keywords : austempered CGI, austempering, scratch testing, scratch plastic deformation, scratch hardness
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