Effects of sub-critical and heat treatments on microstructure and hardness evolution of various grades of wear resistant cast iron.

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The effects of sub-critical and heat treatments are studied on various materials used due to their excellent wear resistance property. This study concerns two ICDP (Indefinite Chill Double Pour) cast irons (a conventional one and one doped with carburigen elements (Nb, V, Ti)) and two high-chromium white cast irons (a conventional one (without Nb) and one containing Nb). The presence of Cr-rich M_7C_3 carbides in Hi-Cr grades, that are harder than cementite present in the ICDP, improves their wear resistance.

Samples were investigated by optical microscope, scanning electron microscope, dilatometry and macro and microhardness tests.

As-cast microstructures are studied and the influence of doping elements is discussed.

An austenisation at high temperature is performed to create retained austenite (RA) to facilitate the study of its behavior during heat treatments. Samples are then quenched and tempered to destabilize the RA and to favor the precipitation of hard fine secondary carbides. For the ICDP grades, double tempering increases the hardness due to the transformation of RA into martensite and to the formation of hard carbides. For Nb-V-Ti-doped grade, the hardness evolution is similar but with lower values. This indicates that the tempering temperature used for this study is not sufficient to destabilize the RA. This is confirmed by dilatometry results.

The cryogenic treatment is performed to fully transform RA into martensite and to study the evolution of the mechanical properties after sub-critical treatments. After austenisation at high temperature and water quenching, five liquid nitrogen quenchings were performed on previsouly water quenched samples, on samples tempered after water quenching, and on quenched and double tempered samples. For ICDP grades, the hardness is higher because the high amount of RA formed after water quenching is transformed into martensite. For the conventional ICDP grade, cryogenic treatment after double tempering doesn't increase the hardness compared to double tempered samples, perhaps because the amount of RA is too small or because the martensite formed after cryogenic treatment is too soft. The same reasoning can be made for Nb-V-Ti-doped grade. For both Hi-Cr grades, the influence of cryogenic treatment on the hardness evolution is quite different. The decrease of Cr, Mo, Nb and C contents of the austenite matrix with tempering leads to the decrease of the hardness of the martensite formed after tempering.

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