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Influence of High Temperature Heat Treatment on in situ Transformation of Mo-rich Eutectic Carbides in HSS and Semi-HSS Grades

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Abstract. Alloys of the complex system Fe-Cr-C-X, where X is a strong carbide forming-element are well known to exhibit interesting mechanical properties, including wear and abrasion resistances. Such a tribological behavior is mainly due to the presence of carbides especially those obtained during the solidification route and that are known as primary or eutectic carbides. It may therefore be interesting to determine the relative stability of primary carbides when considering thermal and thermomechanical treatments performed at a temperature high enough to allow either the homogenization of the matrix or the occurrence of a desired grain size. This thermal stage is often required to produce tailored microstructures that can lead to improved mechanical properties. In this work a series of thermal treatments performed on samples originated from cast foundry parts were done. Raw materials are both HSS and semi-HSS grades used in application where wear resistance is needed. Thermo-Calc® (TC) simulations and Differential Thermal Analysis (DTA) were performed to determine the crystallization behavior and the subsequent solid state transformations of the studied alloys respectively in equilibrium and in non equilibrium conditions. Light and Scanning Electron Microscopies were done together with hardness measurements in order to enhance metallurgical features of the heat treated samples. Image analysis yielded the determination of carbides volume fractions. It appears from microstructural analyses and carbides quantification that Mo-rich eutectic carbides undergo in situ phase transformations during heat treatments. In fact Mo-rich M_2C carbides transform themselves into MC, M_6C and C-rich carbide, through a so-called "budding" phenomenon. Such a phenomenon is the evidence of a preferential migration of some atoms that escape from the parent M_2C carbide to diffuse further away from their initial site with increasing time and temperature. The stable or metastable nature of eutectic carbides is also discussed from DTA and TC results, as M_2C carbides found in both as-conditions and DTA samples were not predicted by equilibrium conditions.