Melting and crystallisation behaviour of multi-component Fe-C-Cr-X alloys: microstructural aspects

J. Tchoufang Tchuindjang and J. Lecomte-Beckers

ASMA Department, Matériaux Métalliques Spéciaux, ULg (IMGC) – Bât. B52 - 1, Chemin des Chevreuils – 4000 Liège (Sart Tilman), Belgium

J.Tchuindjang@ulg.ac.be, Jacqueline.Lecomte@ulg.ac.be
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Studied materials are of the Fe-C-Cr-X multi-component system where X represents a group of strong carbides formers as Mo, V, or Nb. These alloys are used for wear components.

Differential Thermal Analysis (DTA) was used to determine the melting and solidification behaviour of these materials. Raw material has a thermomecanical history that involved casting, heat treating and hot forming, which could be investigated by the melting sequence of the DTA trial (Figure 1). Solidification sequencing allows determination of actual phases in the as-cast microstructure (Figure 2).

In addition to the alloy chemical composition, the as-cast microstructure depends on the cooling rate. This microstructure consists of dendrites surrounded by a more or less continuous network of eutectic carbides, the lattice being composed of bainite, martensite and residual austenite (Figures 3 and 6). But in some cases, δ ferrite can be found at room temperature, which means partial completion of the peritectic reaction (Figures 4 and 5). Prediction of the presence of δ ferrite in the as-cast conditions is of great importance, especially if the cast alloy is to be hot formed or heat treated. Furthermore, the crystallisation kinetics study leads to the determination of segregation phenomena in the microstructure that are connected with the presence of δ ferrite at the end of the cooling sequence.

After performing DTA trials, Optical and Scanning Electron Microscopy are used to characterise matrix and carbides, the nature of those ones being roughly determined by means of Energy Dispersive X-rays spectra.

1. M. Durand-Charre – La microstructure des aciers et des fontes : Genèse et interprétation – (Ed. SIRPE – ISBN 2-906643-27-0).
2. J. Tchoufang Tchuindjang, J. Lecomte-Becker - Microscopic identification of MC, M_2C, M_7C_3, M_6C and $M_{23}C_6$ carbides in High-speed Steels
Proceedings of the International Conference JMM (Joint Microscopic Meeting) – Lille, Juin 2002 - Ed. French Society for Microscopies.

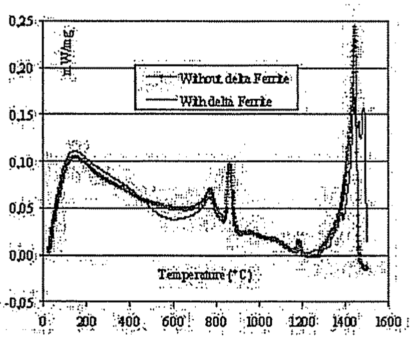

Figure 1. DTA heating curve, starting from the heat-treated state of the alloy

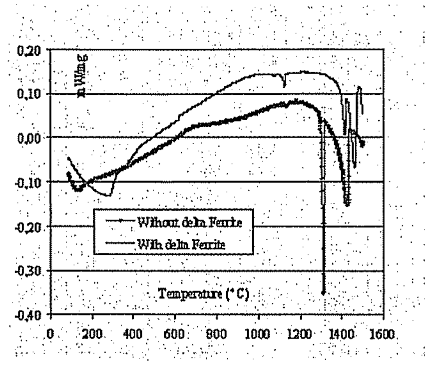

Figure 2. DTA cooling curve, down from the liquid state

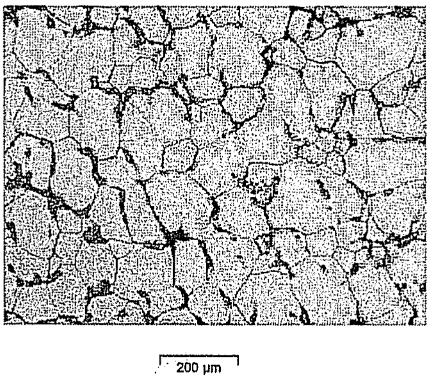

Figure 3. Microstructure at the end of DTA cooling trial (As-cast conditions)

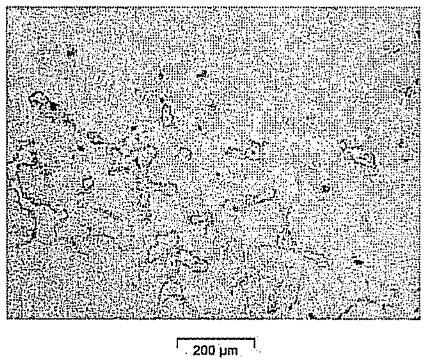

Figure 4. δ Ferrite segregation (Light lobules) in the microstructure at the end of DTA cooling trial

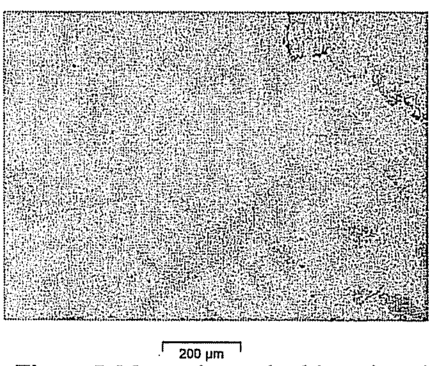

Figure 5. Martensite on dendrite axis and inter-dendritic residual austenite, at the end of cooling trial – Coarse δ ferrite grains (Top right)

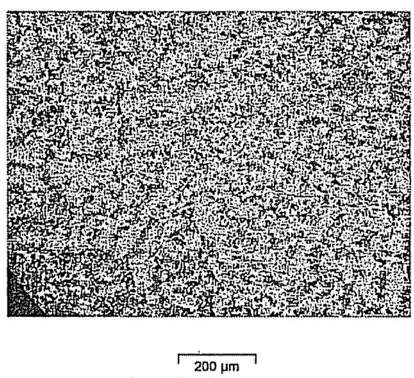

Figure 6. Mixed lattice of martensite, bainite and interdendritic carbides, after annealing (Austenitisation around 1000°C)