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MICROSTRUCTURE OF AN AUTOMOTIVE GRAY IRON CASTING

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The present work was conducted to investigate the microstructure of a gray cast iron used to fabricate cylinder liner of internal combustion engines and that will be hardened by laser radiation in order to achieve better performance in service of this cylinder. The basic chemical composition (wt. pct.) of this material is 3.45C, 2.4Si, 0.65P, 0.75Mn, 0.66Cu, 0.38Cr, and balance Fe.
Samples retired from a cylinder were prepared by conventional metallographic methods and were etched in Nital (5 pct.) for approximately 4 seconds.
The microstructural investigation began by examining the polished sample through optical microscopy (OM). Graphite flakes show up better against a white background before etching. Then, the etched sample was examined by OM, scanning electron microscopy (SEM) and by energy dispersive spectrometry (EDS).
Figure 1 shows the microstructure as polished without etching. The graphite flakes are a mix of types A, B and C, sizes 5 to 8.
The etched samples micrographs obtained by OM and SEM are illustrated in Figures 2 and 3, respectively. The microstructure consists of graphite flakes dispersed in a matrix essentially of fine pearlite (alternating lamellae of light-etching ferrite and darker cementite). There is also a eutectic structure of iron phosphide and ferrite, called steadite. Carbide particles rich in niobium, vanadium, molybdenum, titanium and chromium were characterized by SEM and EDS, as shown in Figures 3 and 4, respectively.
By the features of the microstructure presented above it is possible to conclude that: Lamelar and ramified graphite become the matrix more pearlitic and harder improving the mechanical properties of gray cast iron; the higher contents of carbon and silicon increase the graphitization potential without decomposing the cementite of the perlite which could result in a gray cast iron less resistant and with lower hardness; the steadite phase confirms the presence of the phosphorus in the material.

Although the steadite contributes to the material brittlement it increases the fluidibility of the liquid metal permiting to fill pieces with thinner walls with sharp boundaries; the particles rich in niobium, vanadium, molybdenum, titanium and chromium provide the formation of carbides (MC, Cr_3C_2) that refine the pearlitic structure, increasing the hardness and the strength of a considered section of the material.

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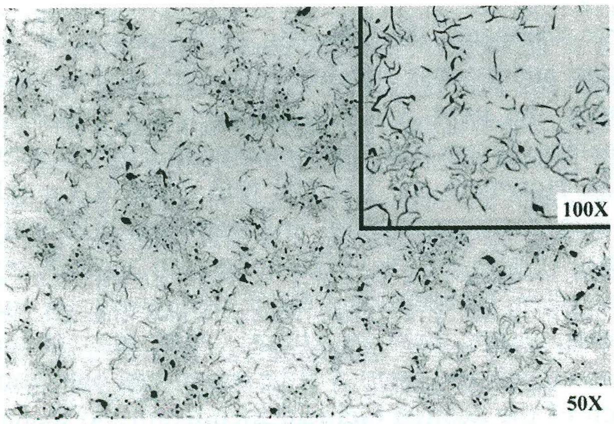

Figure 1 – OM of gray iron; as-polished

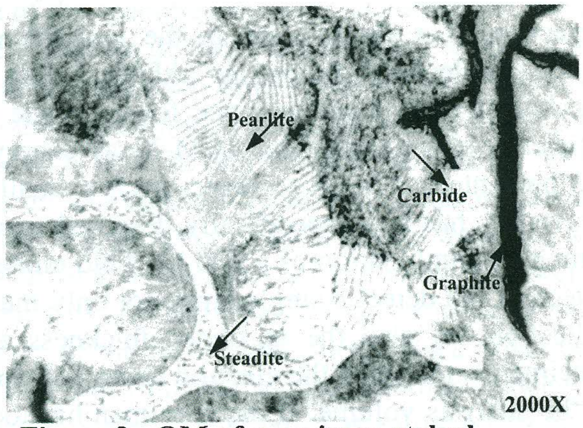

Figure 2 - OM of gray iron; etched

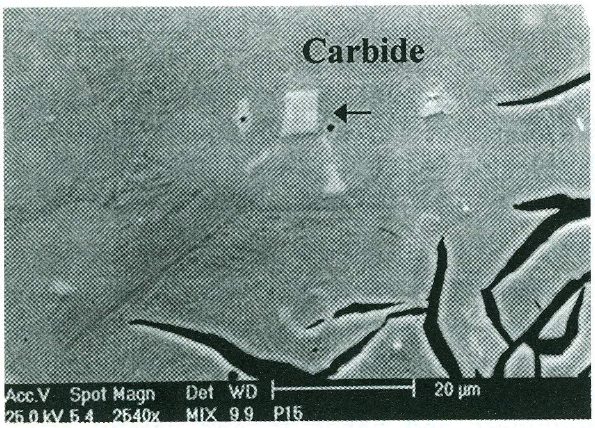

Figure 3 - SEM micrograph of gray iron; Etched.

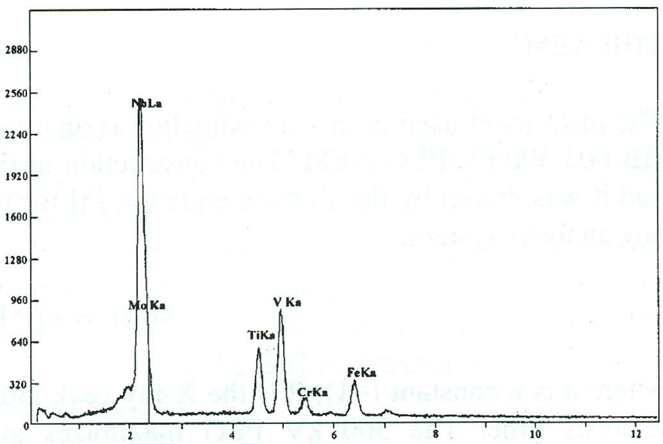

Figure 4 - EDS of carbide particles.