DOI: 10.1017/S1431927603443420
Microsc Microanal 9(Suppl 2), 2003

Scanning Electron Microscopy Study of Spark Erosioned Alpha Iron

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The SEM study of the modification of the surface characteristics of alpha iron produced by electro-spark machining using kerosene as dielectric is presented.

The spark erosion or electro- discharge machining process (EDM) [1] [2], is used to cut and conform conductive materials by means of electric discharges, [3] and to produce small particles, [4][5]. The process is mainly thermal involving heating, melting, vaporizing, diffusion and fast cooling, it consists of the swift electric discharge energy strike on a reduced area of two electrodes submerged in a dielectric. The energy surface density is very high and the temperature on the surfaces reaches the melting point and also the boiling point of the electrodes. A bubble is then formed on the electrodes surface till it explodes and the liquid metal is sucked out and thrown out.

Iron metal sheets, 1.5 mm thickness, 99.95 at.% purity, Fig. 1, were spark-eroded in a commercial machine (CT Electromecánica, Ltd.®, Argentina), with the method of spark-planing at 80V. The discharge duration t_0 and its current I were chosen between 2 μs - 307 μs, and 3.3 A - 25 A respectively. Craters whose diameter depends on the discharge parameters appear on the surface Figs. 2-4 and beneath the material is completely different than the bulk, [6][7]. Austenite, martensite and iron carbides were found when pure iron samples immersed in paraffin were subjected to electro-discharge planing [8] . The layer has a thickness depending on the spark conditions Figs. 5-7 formed by solid phase different to the initial one and to the bulk. Besides of the austenite and martensite different carbides were identified on the surface of pure iron subjected to spark-planed erosion with paraffin as dielectric. In some cases conspicuous frozen structures may be observed on the surface, Figs. 8-9. Carbon containing phases have been found to form after erosion with electric sparks in an organic dielectric. The inclusion of carbon into the original □-Fe coming from the dielectric takes place in a very short time leading to phases out of equilibrium, it is important from the point of view of the technical application of the EDS because the material changes its properties at least in the first microns, due to the incorporation of C from the dielectric and also to the thermal treatment that takes place during the very fast cooling after the discharge.

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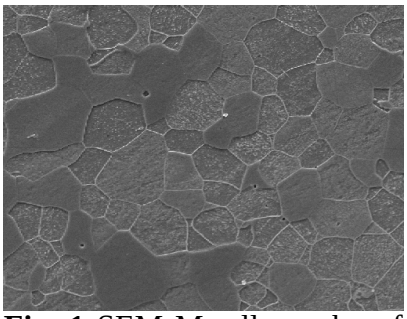

Fig. 1 SEM Metallography of the received material,700 x

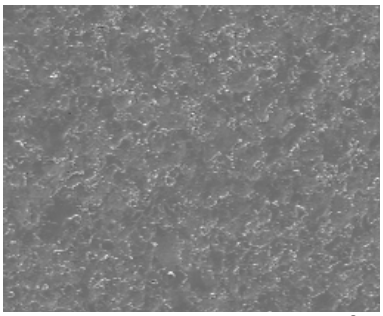

Fig. 3 SEM micrography of 2 : s and 3.3 Amp electrosparked surface, 300 x.

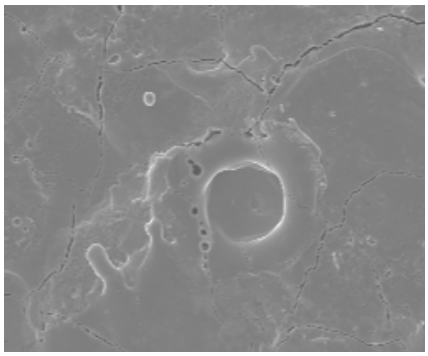

Fig. 2 SEM observation of crater electrosparked by 3.3 Amp and 3072 us 450x

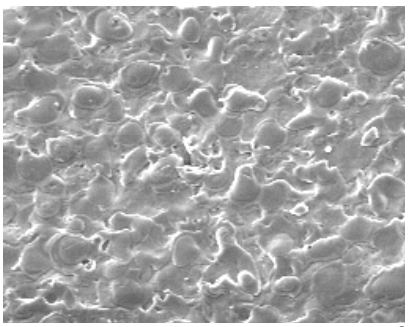

Fig. 7 SEM observation of chimmeys and craters obtained with 3.3 Amp and 2 us, 900 x

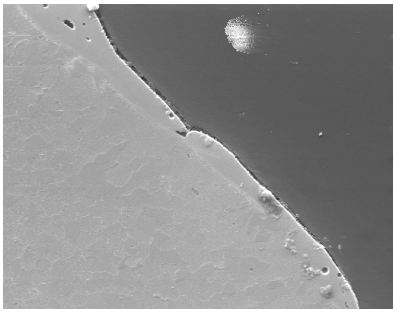

Fig. 9 White zone produced by 3,3 amp and 2 us, 370 x

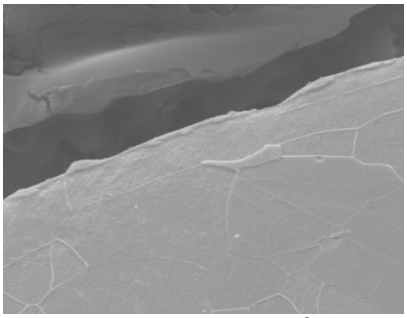

Fig. 8 border of iron elestrosparked with 3.3 amp and 2 us, above the iron structure, 1400x.

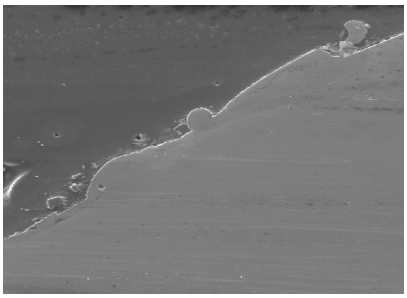

Fig. 6 bordr with frozen ball, 25 amp, 3072 us, 300x

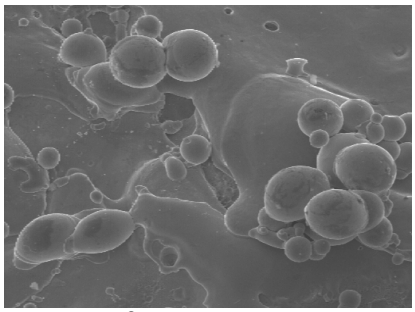

Fig. 4 frozen balls on the surface of 13 Amp and 2048 us electrosparked, 420 x

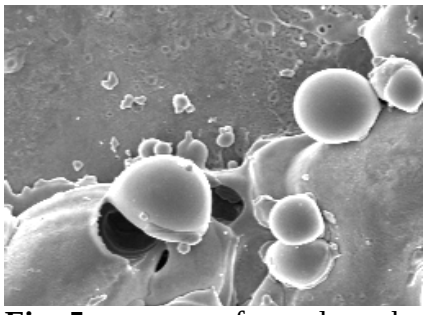

Fig. 5 structures formed on the surface of some samples, 420 x

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