Microscopic determination of the nature of MC, M_2C, M_7C_3 (M_6C) carbides in High-speed Steels

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High-speed steels (HSS), widely used for tools, are characterized by excellent hardness and wear resistance, and high-temperature properties. HSS have been applied for roll materials in order to make rolled plates, because they keep homogeneous thickness and uniform surface during hot rolling, thereby leading to enhanced surface quality of rolled plates and extended roll life.

In the case of the HSS rolls made from centrifugal vertical casting, the final microstructure is composed of a tempered martensitic matrix containing a network of carbides mostly located at grains boundaries. The high hardness and the improved resistance to wear, oxidation and roughness are achieved by adding strong carbides formers like Cr, V, Mo and W.

Overall distribution, nature and carbides size directly affect rolls mechanical properties.

Vanadium forms very hard MC eutectic carbides mainly inside grains, improving hardness and wear resistance. High content of Cr causes formation of M_7C_3 eutectic carbides mainly at grains boundaries, improving hardness and preventing oxidation phenomenon. Both Mo and W lead to the formation of M_2C carbides, which lower the secondary hardening effect during tempering.

Therefore, carbides appear to be of great interest in HSS rolls, especially their nature and their distribution. In order to quantify carbides distribution of HSS rolls, we managed to develop specific etchings to characterize each type of carbides only by means of optical microscopy. The final aim is to quantify the carbides distribution by images analysis on optical samples. One important step to achieve firstly is to determine the nature of these carbides and correlate it to the different shapes and colours revealed by the specific etching.

The present work shows the procedure used to determine the nature of carbides, while using Scanning Electron Microscopy and Energy Dispersive Spectroscopy with X-rays. Then we lay emphasis on optical characterization of carbides. Optical characterization of carbides appear to be the preliminary stage for the general assessment of carbides in HSS microstructure, the final stage of the scheme being the correlation between microstructure parameters (carbides and matrix) and mechanical properties of HSS hot rolling mill rolls.

Mitochondrial heterogeneity during the apoptotic process revealed by probing changes of mitochondrial transmembrane potential

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Dissipation of mitochondrial membrane potential (((m) and release of cytochrome c from mitochondria appear to be key events during apoptosis. The precise relationship (cause or consequence) between both is currently unclear. We previously showed in a model of serum-free cultured granulosa explants that cytochrome c is retained in a subset of respiring mitochondria until late in the apoptotic process. In the present study we further investigated the issue of heterogeneity by using the ((m sensitive probe CM-H2TMRos in combination with a DNA fluorochrome. Changes of ((m were assessed qualitatively by epifluorescence microscopy and were quantified using digital imaging microscopy. This approach yielded the following results: (1) CM-H2TMRos staining is a reliable and specific procedure to detect ((m changes in granulosa cells explants; (2) dissipation of transmembrane potential is an early event during apoptosis preceding nuclear changes, but is confined to a subpopulation of mitochondria within an individual cell; (3) in frankly apoptotic cells a few polarized mitochondria can be detected (Figure arrow). But in the majority of the apoptotic cells CM-H2TMRos fluorescence, however, was no longer detected (Figure arrowhead). These findings support the hypothesis that ATP needed for completion of the apoptotic cascade can be generated during apoptosis in a subset of respiring mitochondria and is not necessarily derived from anaerobic glycolysis.

References

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