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Microstructural Evidences for Exhaustion Theory of Low Temperature Creep in Martensitic Steels

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Abstract : Down-sizing of combustion engines in automobiles are prevailed owing to required increase in efficiency. This leads to a stress increment on valve springs, which affects their intended function due to an increase in relaxation. High strength martensitic steels are used for valve spring applications. Recent investigations unveiled that low temperature creep (LTC) in martensitic steels obey a logarithmic creep law. The exhaustion theory links the logarithmic creep behavior to an activation energy which is characteristic for any given time during creep. This activation energy increases with creep strain due to barriers of low activation energies exhausted during creep. The assumption of the exhaustion theory is that the material is inhomogeneous in microscopic scale. According to these assumptions it is anticipated that small obstacles (e. g. ε–carbides) having a wide range of size distribution are non-uniformly distributed in the materials. X-ray diffraction studies revealed the presence of ε–carbides in high strength martensitic steels. In this study, high strength martensitic steels that are crept in the temperature range of 75 – 150 °C were investigated with the aid of a transmission electron microscope for the evidence of an inhomogeneous distribution of obstacles having different size to examine the validation of exhaustion theory.

Keywords : creep mechanisms, exhaustion theory, low temperature creep, martensitic steels
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