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Fatigue Life Correlations in Low-Alloy Medium-Carbon Spring Steel Subjected to Competing Hardening Schedules

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Abstract

This study establishes quantitative links between
hardening routes and fatigue life in a low-alloy
medium‑carbon spring steel. Oil quench–temper,
austempering, and induction surface hardening were
applied to identically processed bars, followed by systematic characterization of martensite/bainite morphologies, retained austenite, and carbide distributions. Electron backscatter diffraction and X‑ray diffraction were combined to derive microstructure descriptors, which were correlated with rotating-bending fatigue lives through multivariate regression. Induction-hardened specimens exhibited superior high-cycle fatigue resistance due to compressive residual stresses and refined surface martensite, while austempered conditions provided improved crack-initiation resistance at lower stresses. Results are discussed with reference to prior comparative work on different hardening methods for low‑alloy medium‑carbon spring steels, showing how small changes in process parameters can be exploited to tune fatigue performance in suspension components.

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