

MONITORING OF ANNEALED STEEL BEHAVIOR BY A MAGNETIC NDE SENSOR

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ABSTRACT

Steel is one of the most widely used engineering materials for several applications. Steels properties are linked to chemical compositions, processing route and subsequent microstructure. Microstructural features, like, grain size, phase balance, particle size, play dynamic roles to control steel properties. Therefore, microstructure monitoring is prerequisite for achieving desired properties for a specific application. Due to technical complicacy of conventional characterization methods, magnetic Non- destructive Evaluation (NDE) methods are implementing as emerging tools for offline and online monitoring of steel behavior. In this research, the annealing treatment is carried out for 50 and 80% cold rolled ULC steels at temperature range from 200-690°C for offline monitoring their recovery and recrystallization behaviors. The microscopy analysis done by SEM-EBSD method, correlating to hardness and soft magnetic properties as a function of annealing treatment. At 500°C, the recovery causes no significant changes in microstructure and hardness, while magnetic coercivity decreases about 40 and - 45% and permeability rises for 50 and 80%CR steels, respectively. The recrystallization is observed after annealing at $T > 600^{\circ}\text{C}$, confirming by the lowering of microstructural KAM value from 1.46° to 0.72° and to 0.60° and hardness drop from 184.5 to 151.1 HV and 200.6 to 123.1 HV for 50 and 80% CR steels, respectively. Moreover, the angular dependence of V_{rms} is explained as magnetic texture for stages of recovery (500°C) and partial recrystallization. The large change of V_{rms} is found in RD than TD, indicating the presence of promising magnetic easy axis along RD. After recrystallization completion (660°C for 50% and 640°C for 80% CR steels), the V_{rms} variation is very small, altering the anisotropy behavior to a circular shaped (isotropy). The research outcomes have a scope for online monitoring of steel microstructural behavior infuture.

Keywords: Cold rolled steel, annealing, EBSD, magnetic NDE, hardness.

