1.1.5. ASSESSMENT OF MICROSTRUCTURE AND TEXTURE EVOLUTION DURING RECOVERY AND RECRYSTALLIZATION BY MAGNETIC METHODS

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Magnetic hysteresis (B–H) loop and Barkhausen noise measurement techniques have been used to non-destructively characterize microstructural features of several steel types. The present contribution reviews some of the most important results obtained in the last years of research on the capacity of these magnetic methods to provide non-destructive information of the microstructure and texture evolution during the annealing of cold rolled low carbon steels, due to recovery and recrystallization processes.

Several mechanisms contribute to the magnetization of a ferromagnetic material in different regions of the B–H loop. The influence of the evolution of microstructural features and of texture during annealing treatments at various temperatures on these regions of the B–H loop has been studied. On the one hand, parameters in the "low induction region", below the knee of the curve, where the 180° domain wall movements predominate, are mainly affected by the average dislocation density and grain size. On the other hand, parameters at the "high induction region", above the knee, where domain rotations occur, are controlled by crystallographic texture.

The annihilation of dislocations that takes place during the recovery processes can be related to the evolution with annealing time of the parameters derived from the low induction region like the coercive force. Additionally, the total hysteresis losses can also be used to characterize the recovery processes, because the main contribution to these losses comes from the low induction region. On the contrary, two competitive microstructural effects occur during recrystallization: the annihilation of a large number of dislocations which tends to reduce the number of pinning sites and the creation of new grain boundaries that hinder the movement of the domain walls. It is concluded that the coercive field can be used to monitor the recrystallized fraction when the decrease in the effective grain size during recrystallization is small. Moreover, the texture of the material changes during recrystallization and affects the high induction region of the B–H loops. The capacity of characterizing recrystallization of parameters derived from this induction region is discussed in terms of magnetocrystalline energies calculated from the crystallographic texture of the steel.

Regarding parameters derived from magnetic Barkhausen noise (MBN), experimental results show that they can be used to characterize recovery and recrystallization processes. The evolution during the annealing of the MBN parameters derived is discussed in terms of the number of pinning sites and of the mean free path of the domain wall displacement. The effect of the distinct microstructural features and texture on different parameters of MBN can not be separated as clearly as in B–H loop parameters.