Improved magnetic performance of Cobalt-based ribbons by nanocrystallisation through magnetic annealing

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Abstract

Phase transformation driven soft magnetic properties have been correlated through different stages of nano-crystallisation of Co-based amorphous alloys, via transverse magnetic annealing, by combining structural, magnetothermal, domain imaging, and AC/DC magnetometry techniques. The nano-crystallisation starts by nucleation and growth process of soft magnetic *meta*-stable, thermodynamically favoured, $Co_{23}B_6$ phase with less nucleation activation energy compared to other stable phases. In the second crystallisation stage, Co_2B and Co_3B, as a semi-hard magnetic phase, are identified in the alloys, magnetically annealed at 525 and 550 °C, respectively. Field-induced anisotropy dominates over the residual contributions of magneto-crystalline anisotropy of the phases, precipitated after field annealing at 510, 515, and 525 °C. The anomalous loss is significantly reduced by annealing in a transverse magnetic field due to the reorientation of the preferred magnetisation axis, and consequently, change in dominant magnetisation reversal mechanism from domain wall motion to magnetisation rotation. In addition, magnetic annealing causes a measurable decrease in the domain width, which, in turn, promotes pinning and inhibits domain wall motion, thus further favours coherent domain rotation as the primary mechanism of magnetisation. The combined mechanism of nanocrystallisation and coherent magnetisation rotation accounts for a 70% decrement in the anomalous loss in the so-processed ribbons at 525 °C, which renders them attractive for applications in mid- and high-frequency power supplies and inverters.