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Soft Magnetic Materials for Improved Energy Performance[1]

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A main focus of sustainable energy research has been development of renewable energy technologies (e.g. from wind, solar, hydro, geothermal, etc.) to decrease our dependence on non-renewable energy resources (e.g. fossil fuels). By focusing on renewable energy sources now, we hope to provide enough energy resources for future generations. In parallel with this focus, it is essential to develop technologies that improve the efficiency of energy production, distribution, and consumption, to get the most from these renewable resources. Soft magnetic materials play a central role in power generation, conditioning, and conversion technologies and therefore promoting improvements in the efficiency of these materials is essential for our future energy needs. The losses generated by the magnetic core materials by hysteretic, acoustic, and/or eddy currents have a great impact on efficiency. A survey of soft magnetic materials for energy applications will be discussed with a focus on improvement in performance using novel soft magnetic materials designed for these power applications. A group of premiere soft magnetic materials – nanocrystalline soft magnetic alloys – will be highlighted for their potential in addressing energy efficiency. These materials are made up of nanocrystalline magnetic transition metal-rich grains embedded within an intergranular amorphous matrix, obtained by partial devitrification of melt-spun amorphous ribbons. The nanoscale grain size results in a desirable combination of large saturation induction, low coercivity, and moderate resistivity unobtainable in conventional soft magnetic alloys. The random distribution of these fine grains causes a reduction in the net magnetocrystalline anisotropy, contributing to the excellent magnetic properties. Recently developed $(Fe,Co,Ni)_{88}Zr_7B_4Cu_1$ alloys will be discussed with a focus on the microstructure/magnetic property relationship and their effects on the energy efficiency of these materials for AC applications.

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