Soft magnetic materials, from statics to radiofrequencies

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There are multiple ways in which magnetic materials can contribute to saving electric power and reducing CO_2 emissions. For example, the conversion of electrical energy into mechanical work and vice versa is done using electric motors and generators, respectively, which imply the use of hard and soft magnetic materials. For electric vehicles, magnetic materials which retain their properties up to moderately high temperatures are needed. Advanced amorphous and nanocrystalline soft magnetic materials are also of interest for inductors/transformers in high frequency power electronics components and power conditioning systems. Thus, optimizing soft magnetic materials and extending the temperature span in which they are applicable can imply a notable enhancement in the energy efficiency of these devices.

In this lecture we will overview the different families of soft magnetic materials with current technological interest, ranging from those which represent the largest volume in the global market (non-oriented and grain oriented electrical steels) to those with the lowest coercivity (amorphous and nanocrystalline alloys). We will focus on the mechanisms by which low coercivity values can be achieved, as well as on the different properties which should be optimized for a material to be suitable for its application as a soft magnet in the quasistatic frequency range or up to radiofrequencies.

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