HIGH POWER-DENSITY MAGNETIC MATERIAL

A new material with low coercivity and high resistance to change in magnetization, together with a high saturation magnetization. Monash researchers have created a high power-density magnetic material that overcomes the challenge of achieving both characteristics.

- **Soft-magnetic material with high power density**
- **Saturation magnetization > 2T**
- **Core loss (400Hz, 1T) ~ 2 W/kg**
- **Cobalt content ~ 20%**
- **Ultra-rapid annealing > 10^4 K/s**
- **Nanocrystalline**

THE CHALLENGE

Soft magnetic materials are used to confine and guide magnetic fields, for example when building electric motors, transformers and instruments.

Unlike permanent magnets, soft magnetic materials, can be easily magnetized and de-magnetized by applying an external magnetic field as shown in Fig. 1.

Ideally, soft magnetic materials have a high magnetization at saturation (Fig. 1, y-axis) and a small applied field at the coercivity point (Fig. 1, x-axis).

Materials with a high saturation magnetization or low coercivity are well known. Adding cobalt (Co) to iron (Fe) is well known to increase the saturation magnetization of the resulting alloy. However, keeping the coercivity and core losses low remains a challenge.

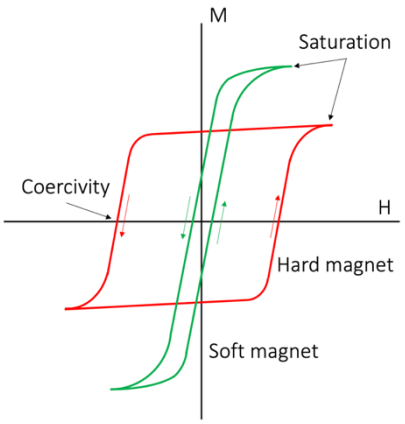

Figure 1: Soft and hard magnetic properties

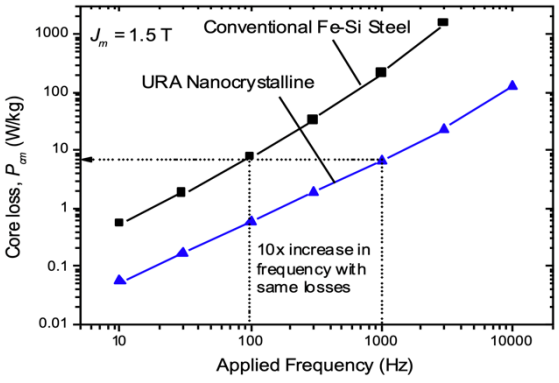

Figure 2: Core losses

THE TECHNOLOGY

Monash researchers have created a new material that combines high magnetization saturation (> 2T) comparable to existing Fe-Si steel, that possess low coercivity (< 10 A/m). As a result, the new material can be efficiently magnetized and demagnetized **with minimal core losses**, even at high frequencies, as seen in Fig. 2.

This novel cobalt-containing composition is first produced as an amorphous structure. The material is then nanocrystallized using an ultra-rapid heating process (>10 K/s) within specific temperature ranges and heating rate.

Use of a cobalt-containing alloy is expected to result in a relatively high costs; our material is therefore best suited to applications where high power-density and/or efficiency is required, such as in the aerospace and medical industries.

Intellectual property: An Australian provisional patent was filed in 2019.

The Team

The team is led by Prof K Suzuki and Dr R Parsons in the Department of Materials Science and Engineering at Monash University.

THE OPPORTUNITY

The team is looking to build prototype devices, such as electric motors or inverts, to prove the suitability of this material in a variety of applications.

We seek a partner to take this opportunity to market.

Reference

1. R Parsons, Z Li, K Suzuki (2019) Nanocrystalline soft magnetic materials with a saturation magnetisation greater than 2T, Journal of Magnetism and Magnetic Materials 2019, doi:10.1016/j.jmmm.2019.04.052.

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