

High power-density magnetic material

PHYSICAL SCIENCES: Materials

<p>The Challenge</p>	<p>Soft magnetic materials are used to confine and guide magnetic fields, for example when building electric motors, transformers and instruments.</p> <p>Unlike permanent magnets, soft magnetic materials can be easily magnetised and de-magnetised 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).</p> <p>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.</p>
<p>The Solution</p>	<p>Our solution is a new Fe-based material with low coercivity brought about by nanostructures, together with a high saturation magnetization by Co addition. We have created a high power-density magnetic material that overcomes the challenge of achieving both characteristics.</p>
<p>Key benefits</p>	<ul style="list-style-type: none"> • Soft-magnetic material with high power density • Saturation magnetization > 2T • Core loss (400Hz, 1T) ~ 2 W/kg • Cobalt content ~ 20% • Ultra-rapid annealing > 10⁴ K/s • Nanocrystalline
<p>Development Stage</p>	<p>Validation</p>
<p>Brief Description & Differentiation</p>	<p>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 (Fig. 2).</p> <p>This novel cobalt-containing composition is first produced as an amorphous structure. The material is then nanocrystallised using an ultra-rapid heating process (>10 K/s) within specific temperature ranges and heating rates.</p> <p>Use of a cobalt-containing alloy is expected to result in a relatively high cost; 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.</p>
<p>Research Team</p>	<p>Led by Prof Kiyonori Suzuki and Dr Richard Parsons (Materials Science and Engineering)</p>
<p>Intellectual Property</p>	<p>Australian Provisional Patent application filed in 2019.</p>
<p>Key Publications</p>	<p>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.</p>

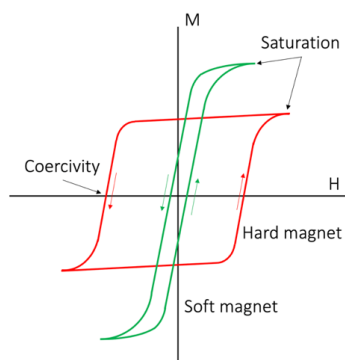


Figure 1: Soft and hard magnetic properties

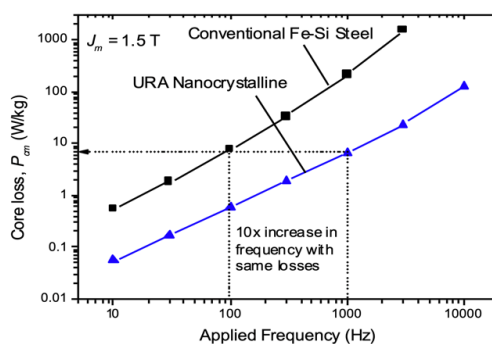


Figure 2: Core losses