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New Nanomet Alloy Powder Enables More Efficient and Higher-Density Inductors for AI Infrastructure

Introduction

The efficiency and power density of magnetic components have always been critical in electronic systems. However, with the exponential rise in global data generation driven by artificial intelligence (AI), these requirements have become even more urgent. AI servers now consume three times more energy than traditional systems, with power demands exceeding 1000 A for AI accelerators, pushing datacenter utility power to its limits. Given that datacenters already account for over 2% of global energy consumption, innovations in power solutions are essential for both energy savings and system efficiency. This article introduces a new magnetic material designed to meet these intensified performance and efficiency demands, focusing on optimizing inductors for CPU, GPU, and FPGA power applications in AI-driven infrastructure.

Background

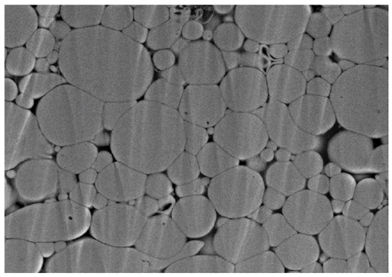
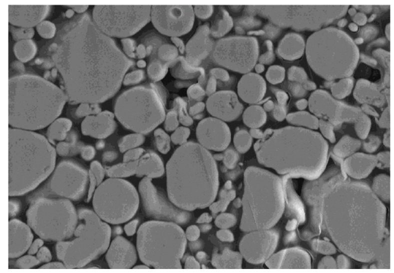
High saturation magnetic flux density (Bs) and low coercivity (Hc) are essential for efficient inductor performance in electronic devices. A high Bs allows the inductor to handle stronger magnetic fields without saturating, enabling it to carry higher currents and store more energy—particularly important in applications that require compact designs with high power output, such as AI systems. Low Hc, on the other hand, means the material requires less energy to magnetize and demagnetize, reducing energy losses and improving overall efficiency.

Traditional magnetic core materials, like Mn-Zn and Ni-Zn ferrites or Fe-Si alloys, have long been used in these applications but often struggle to balance high Bs and low Hc. This trade-off limits their effectiveness, particularly as devices grow more power-hungry.

YAGEO Group's recent breakthrough in hot molded nanocrystalline materials is a significant improvement achieving both high Bs and low Hc - something previously impossible to achieve with conventional materials. Among these innovations, Fe-based alloys, specifically Fe-B-P-Cu nanocrystalline alloys, have shown exceptional potential.

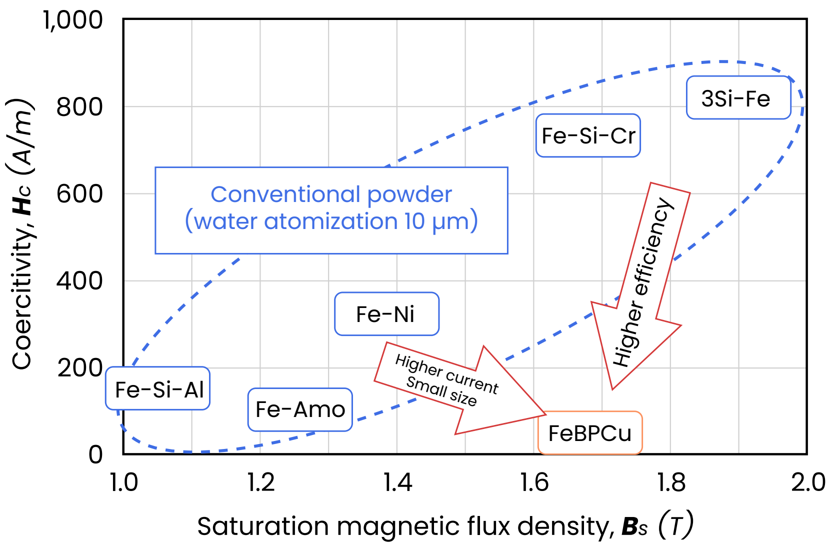
The Results

YAGEO Group's Nanomet was created through rapid quenching, resulting in a smooth, spherical powder. After precise annealing, the alloy exhibits a fine nanocrystalline structure with remarkable magnetic properties, including a coercivity as low as 23 A/m and a saturation magnetic flux density of 1.55T through hot molding (as shown in Figure 1). These figures are impressive compared to conventional magnetic powders, making this alloy an excellent material for creating efficient, high-performance inductors.

	Nanomet	Conventional Fe-Si-Cr
D_{50} (μm)	21	10
H_c (A/m)	23	720
B_s (T)	1.55	1.28
SEM Image	Spherical shape  10(μm)	Deformed shape  10(μm)

Through a series of experiments, YAGEO Group demonstrated that the FeBPCu powder outperforms traditional materials (as shown in Figure 2). The material not only has the second-highest saturation magnetic flux density (Bs) but also exhibits exceptionally low coercivity. Its unique nanostructure reduces energy loss and features a soft saturation characteristic, making it ideal for high-frequency inductors used in AI-driven electronics.

Figure 2, Hc versus Bs Comparisons



YAGEO Group has designed, and is in production, with multiple single and dual-phase inductors to support CPU/GPU/FPGA power requirements using this new proprietary material. One such use case was the need for a 70nH, 9.8x4.0x6.0mm, single-phase inductor for a 6v to 1.8v, 1MHz buck regulator (Figure 3a). The saturation curve (Fig 3b) compares Nanomet, conventional metal composite ferrite inductors. It can be seen that the saturation current of the Nanomet inductor exceeds 160A, which is nearly 3x the saturation of the conventional ferrite inductor (50A at 100C) and that the energy storage (.5*L*I2) for the Nanomet is 40% higher than conventional metal composite.

Figure 3a, Inductor Construction

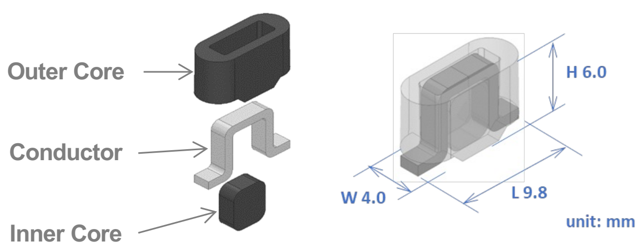


Figure 3b, Inductance versus Current

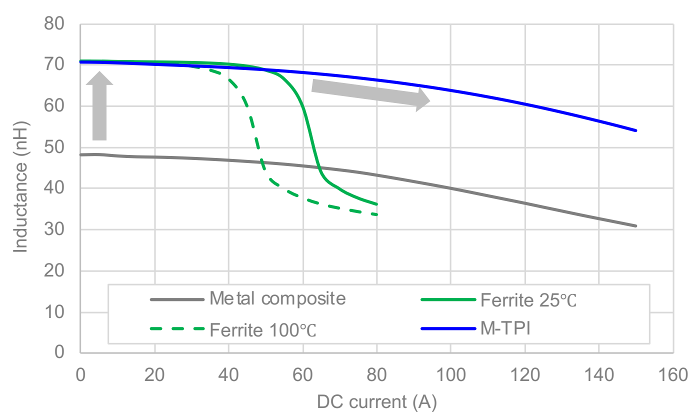
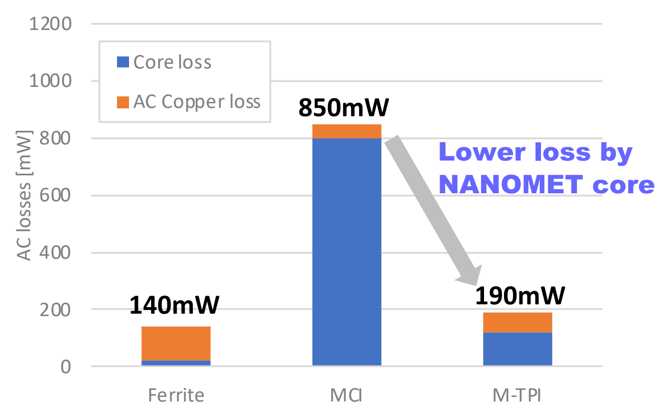


Figure 3c, AC Switching Loss



In addition, the AC losses (Figure 3c) of the Nanomet core are 4.5x lower than a conventional metal composite inductor and only 50mW more than ferrite. Clearly, the Nanomet inductor is a superior solution that also benefits from the fact that it can be molded into a wide arrange of shapes making complex inductors possible.

A low-lost, temperature-stable, soft-saturating moldable inductor has long been the goal for magnetic component designers and power supply engineers. YAGEO Group's Nanomet realizes this goal.

Contact us for more information.