New production process optimises surface and bulk electrical steel properties

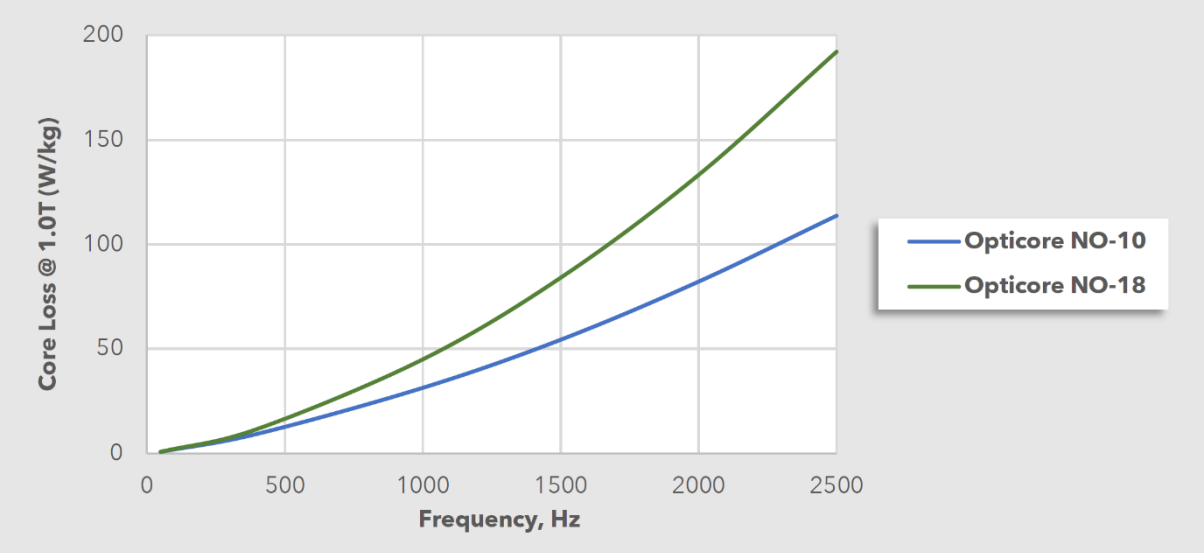
A new production technology allows variation of properties through sheet steel. Arcanum Alloy's vapour transport technology can enable surface properties to be more beneficial to magnetic properties and core properties which better manage the flow of electricity and mechanical forces. These improved steels could enable higher efficiency and power density machines.

Arcanum Alloys, Inc. of Grand Rapids, Michigan, USA, has developed a platform technology that dramatically improves the steel manufacturing process and uses this technology to make Spatially Optimized Diffusion Alloy (SODA™) products.

In the SODA process, alloying elements such as Silicon, Aluminium, Manganese, etc. are diffused through the sheet by vapour transport after the steel has reached a finished or semi-finished form. This technology allows the surface and bulk properties of the steel to be decoupled, which means the performance of each region can be optimised independently. So, for example, surfaces can be optimised for magnetic properties, and core areas focussed on managing the flow of electricity and mechanical loads.

Understandably the chemistry and metallurgy underlying this manufacturing technology is a tightly guarded commercial secret for now, as Arcanum are entering into the thin-gauge Non-Oriented Electrical Steel (NOES) market – a competitive field already occupied by players with substantial resources.

Arcanum's Opticore™ is a range of light-gauge NOES ranging from 0.20 mm down to 0.10 mm. These high-performance grades offer both excellent core loss and induction properties, while retaining the high strength needed in some high-frequency motor and generator applications. As an example, Opticore NO-10 grade offers core loss less than 10 W/kg at 1 T and 400 Hz, while maintaining an induction greater than 1.59 T at a field strength of 5000 A/m, and with a yield strength of greater than 390 MPa. In the graph below, two grades of Opticore are compared over a range of frequencies at a 1 T magnetic induction. Competitor core losses are expected to be somewhere above the NO-10 line, but direct comparisons are difficult to make at this time.



These improved properties could help meet the growing demand for machines using motor and generator cores exhibiting high-efficiency and power density, without resorting to Nickel or Cobalt alloys.

Machine and system design both have a substantial impact on actual machine performance in a specific application, but in general lower core loss, higher induction or magnetic flux density, and higher strength are beneficial to a typical machine design as:

- Better induction properties can offer benefits around power density and power consumption for a given use profile.
- Lower core loss properties offer higher motor efficiency and lower heat generation.
- Better efficiency could mean battery powered motors last longer with a typical use profile, and in some cases avoid the need for extra cooling capacity with its additional cost, weight, space, and energy use.
- Material strength can become a factor for faster spinning motors – high speed motors can spin fast enough to deform the outer parts of the rotor if the yield strength is insufficient, and since tolerances between the rotor and stator can be very tight, any dimensional instability of the rotor can cause substantial damage to the motor.

Arcanum's SODA technology applied to NOES grades positively impacts induction, core loss, and mechanical strength, enabling applications such as high-frequency motors fitting compact form factors without cooling systems, motors with more torque for the same power, or increased range for the same energy input.

For more information on Opticore or other SODA products, please visit:

www.arcanumalloys.com

or email

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About the UK Magnetics Society

People involved with the UK Magnetics Society believe that magnetism in all its forms is an amazing force, and that by understanding and harnessing it people can deliver amazing things. We are called the UK Magnetics Society, but only because we started there. There are no limits to members, delegates, events or content – as our resources allow, we always have and always will engage worldwide, supporting magnetics professionals in all fields or countries, and in industry, government and academia.

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