MATERIALS ENGINEERING
SEMINAR

"High-Resistivity Electrical Steel Thin Strip by Hybrid Deformation Processing"

By B. Stiven Puentes Rodriguez
Purdue MSE PhD Dissertation
Advisor: Professor Kevin Trumble

ABSTRACT

Electrical steels are one type of soft magnetic material. They are based on Fe-Si alloys and are widely used for magnetic cores in transformers and electric motors. It is well known that Fe-6.5Si wt% is the most efficient composition that has been developed so far. However, at such a high silicon concentration (6.5wt.% = 12.1 at.% Si in Fe), the workability of the alloy is so bad that it makes it extremely difficult for industrial rolling production. For this reason, commercial production of electrical steel is limited to ~3.2Si wt%

This problem was approached in two different ways. First, a machining-based technology that suppresses the mechanisms that lead to cracking during traditional rolling was applied for making thin strips. Novel machining-based sheet production technologies called free machining (FM), and hybrid cutting extrusion (HCE) were used to produce strips of high resistivity electrical steel. The maximum strip width achieved was 50 mm, and it was produced with a combination of FM and light rolling with a surface roughness comparable to cold-rolled sheet surfaces.

Second, a new experimental alloy Fe-4Si-4Cr wt% was developed with improved magnetic properties compared to ~ Fe-3.2Si wt% and outstanding workability. Results report that the new experimental alloy has an electrical resistivity of 85 ± 3 $\mu\Omega \cdot cm$, which is higher than Fe-6.5%Si. Also, the results on the Fe-4Si-4Cr workability show that this new alloy can withstand 75% cold-rolled reduction. The magnetic properties characterization was done via standard stacked toroidal test, and results show that the experimental alloy has an excellent magnetic performance with a reduction in core loss of 33% at 400 Hz compared to commercial alloys with ~ Fe-3.2Si wt%.

Date: Thursday, June 30, 2022
Time: 8:30am
Location: ARMS 1021 or via WebEx https://purdue.webex.com/meet/driscol

PURDUE UNIVERSITY
School of Materials Engineering