Polymer processing with engineered magnetic nanoparticles

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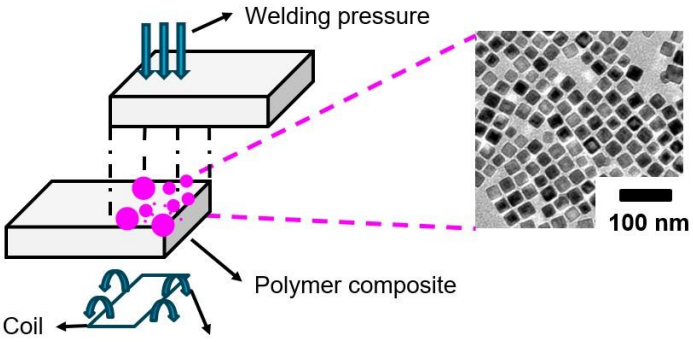
Introduction

The aerospace industry has increasingly prioritized sustainability by adopting lightweight materials. Thermoplastic polymers are gaining attention due to their recyclability and ease of reshaping. As the demand for high-performance structures grows, advanced joining techniques are becoming essential. Traditional joining methods are expected to be replaced by fusion bonding, with induction welding standing out for its non-contact nature and continuous processing capability.

Induction welding is a contactless high-speed method of joining thermoplastic composites. It typically relies on the Joule heating of a highly conductive (metallic) susceptor in an alternating field. Instead of a conducting susceptor or conductive carbon fiber textiles, we suggest using a polymer containing a small fraction of superparamagnetic nanoparticles.

Potential advantages of our approach:
1) Reduced effect on the composite mechanical characteristics (minimally invasive)
2) Spatial uniformity of melting
3) Heating ability of nanoparticles should cease near Curie point – using this property, one can develop a thermally self-regulated melting process.



Topics

- Optimization of available characterization techniques for magnetic nanoparticles. DSC, TGA, VSM have been previously explored by researchers of the group, however, perfecting experimental protocols is essential to obtain reliable and consistent information regarding magnetic nanoparticles. In addition, an innovative type of equipment for magnetic measurements (DynoMAG), is now available for the group, expanding opportunities for testing. The master student will be highly involved in experimental/characterization work and in the kick-off of DynoMAG equipment.
- Finally, another possible study aims to establish optimal processing parameters for the compounding of thermoplastic polymers containing magnetic nanoparticles. The production and testing of polymeric samples (PA, PP…) is essential to evaluate their rheology and mechanical properties, in addition to studying self-assembly phenomena of MNPs. This work will be relevant to ensure a solid understanding of compounding parameters for future embedding of MNPs in aerospace parts. The student will be involved in both compounding and mechanical testing of polymeric samples.

Activities & areas of interest

- Composite materials
- Fusion bonding
- Magnetism
- Magnetic nanoparticles
- Induction heating
- Heating phenomena
- Materials characterization techniques

This work is suitable for Master/Bachelor students. Sounds interesting? Please get in touch!