

An Indian-Australian research partnership

Directional atomic ordering related magnetic anisotropy in bulk amorphous alloys

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The problem

Amorphous magnetic alloys have been studied extensively since early 1970s owing to their magnetic properties such as low coercivity, high permeability and high saturation magnetization which are highly suitable for transformer cores. In spite of the attractive properties the application of amorphous alloys has been limited due to the fact that extremely high cooling rates, $> 10^6 \text{ Ks}^{-1}$, are required to make them amorphous, which restricts the shape to ribbons with typical thickness of 20 μm along the heat transfer direction. The large critical cooling rate restriction has been recently overcome with the discovery of a new class of multi-component alloys which require low cooling rates to become amorphous. These multi-component alloys are commonly referred to as 'bulk amorphous alloys'. The recent observation of excellent soft magnetic properties in Fe-early transition metal-metalloid systems has revitalized research on amorphous magnetic alloys.

The lack of long range translational symmetry in atomic arrangement in the amorphous alloys leads to a lack of magnetocrystalline anisotropy and hence excellent soft magnetic behavior. Anisotropic behavior in the amorphous alloys can however be induced by designed annealing which results in directional atomic ordering. Despite the significance of such anisotropy on the soft magnetic behavior, there are very few reports which investigate this phenomenon.

The project

The main objective of this proposal will be to study the effect of directional annealing induced atomic ordering on the magnetic anisotropy of bulk amorphous alloys. Directional annealing will be done both in static and rotating magnetic fields. The microstructural and magnetic property changes produced by this annealing treatment will be investigated in detail. A variety of multi-component alloy systems such as Fe-based systems and Heusler alloy based systems will be the materials of focus in this project proposal.

The alloys will be synthesized from pure elements and subjected to bulk amorphisation at IITB and Monash University. The obtained bulk amorphous alloys will be annealed in static and rotating magnetic fields using the facilities at Monash University. The microstructure and magnetic properties of the resulting alloys at different stages will be investigated both at IITB and Monash University.