Modification of Magnetic Properties for Single Layer and Laminated Cores of Cobalt Rich Amorphous Films Resulting from Post Deposition Magnetic Annealing

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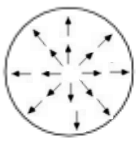
DESCRIPTION :-

This work investigates the effect of post deposition Magnetic Annealing to modify the induced magnetic anisotropy and coercivity of sputtered cobalt rich amorphous thin films and laminated cores. Studies were carried out both on a) Samples deposited with no magnetic field and subsequently magnetically annealed and b) Samples deposited in a magnetic field and subsequently magnetically annealed with stronger field strengths The study utilizes a magnetic annealing tool, capable of applying fields of up to 5 Tesla at different orientations during thermal processing. The measurement of magnetic properties was carried out using a ShB Mesa B-H loop tracer

MAIN CONCLUSIONS :-

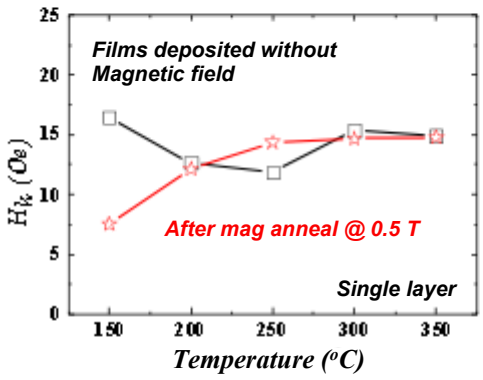
- For single and multilayer films deposited without a magnetic field; post deposition magnetic annealing is shown to reorient the 'as deposited' radially distributed anisotropy by up to 90° providing the opportunity to achieve uniform unaxial anisotropy over a wafer.
- The strength of the magnetic anisotropy can be further tuned in unaxial anisotropic thin films by reorientation of the magnetic anisotropy, by a post deposition magnetic annealing process.
- The effects of applying a 0.5 Tesla field during annealing is reported in this work. Investigation using fields up to 5 Tesla is planned.

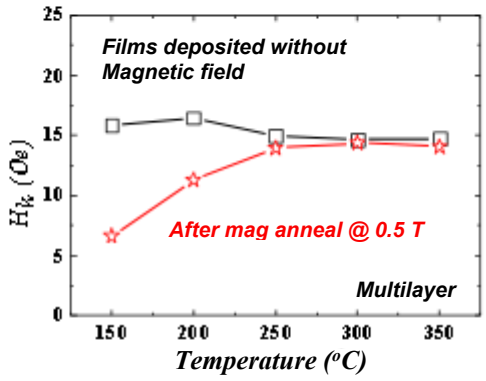
a) Deposited with no magnetic field & then magnetically annealed



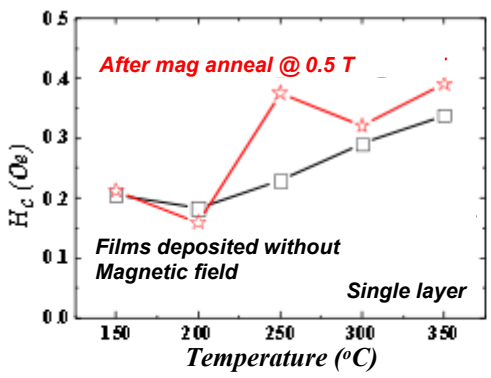
'As deposited' anisotropy direction distributed radially in the wafer.

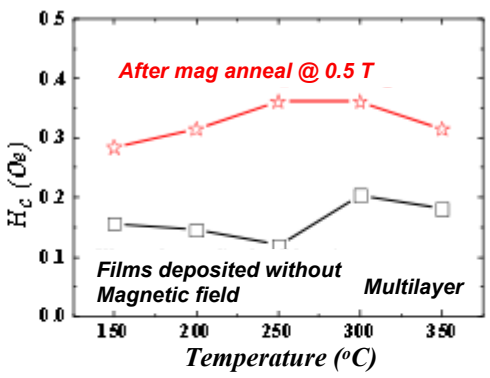
After Magnetic Annealing, uniform magnetic properties across the wafer can be achieved





- When films are deposited without a magnetic alignment, the magnetic anisotropy is often radially distributed. Unaxial anisotropy in thin film materials is required rather than a radially distributed anisotropy, to overcome the material losses at high frequencies.
- Our results of magnetron sputtered Co-rich thin film materials show that the radially distributed anisotropy in as-deposited films can be reoriented at 90° by a post deposition magnetic annealing process.
- The reorientation of anisotropy in the thin film materials provides the opportunity to achieve uniform magnetic properties over the full wafer.

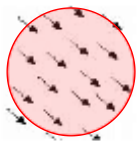




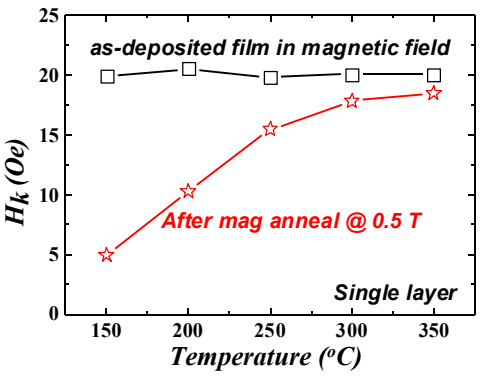
- H_c is in a similar range for single layer films before and after annealing
- H_c increases for multilayer films after magnetic annealing in a field of 0.5 Tesla at temperatures up to 350 °C, with maximum <0.4 Oe

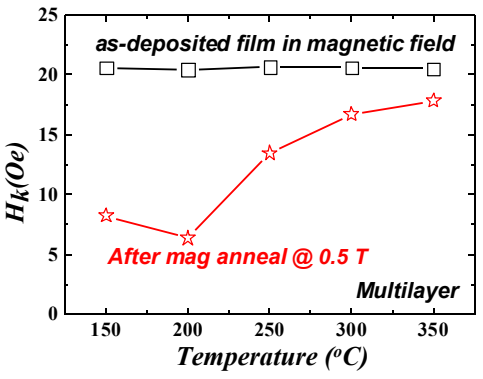
b) Deposited in a magnetic field & then magnetically annealed

Deposition in a magnetic field can achieve uniform magnetic properties

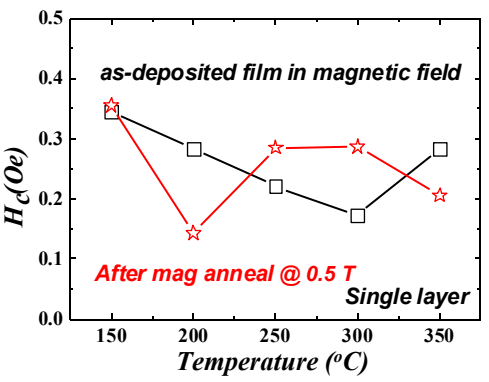


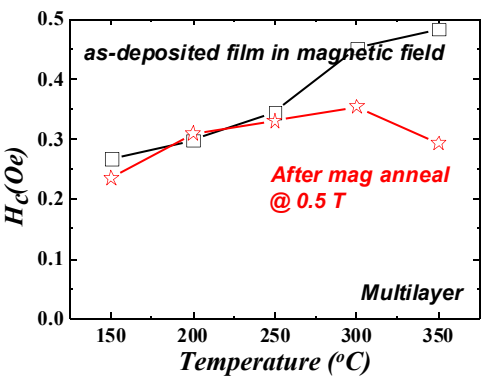
The direction of anisotropy can be reoriented and its value 'tuned' by post deposition magnetic annealing



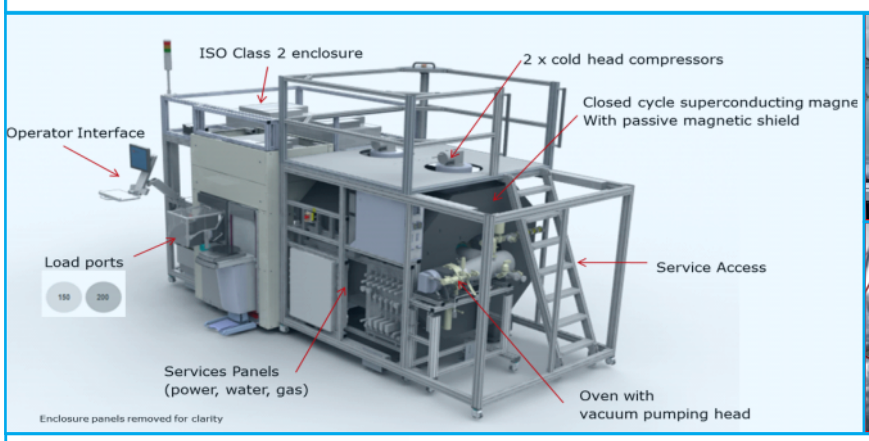


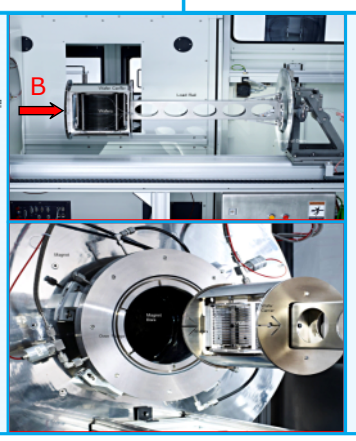
- The magnetic anisotropy can be further tuned in unaxially anisotropic thin film materials deposited by in-situ magnetic alignment process.
- The temperature dependence of re-orientation of magnetic anisotropy of unaxial anisotropic thin film materials provides the opportunity to tune the permeability *(permeability is inversely proportional to H_k)* of the materials to achieve the required inductance density in devices for high frequency applications.



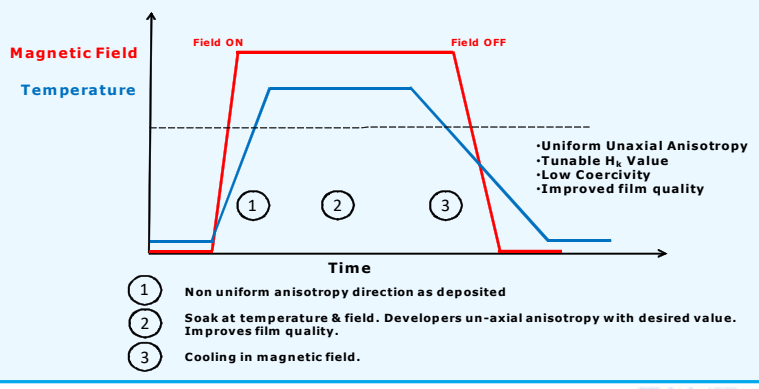


- H_c decreases in multilayer films following post deposition magnetic annealing at temperatures >250 °C in a field of 0.5 Tesla.





Magnetic Annealing process



1. Non uniform anisotropy direction as deposited
2. Soak at temperature & field. Developers un-axial anisotropy with desired value. Improves film quality.
3. Cooling in magnetic field.

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