Aalto Symposium on New Functional Materials

Flexible magnets through ALD-MLD

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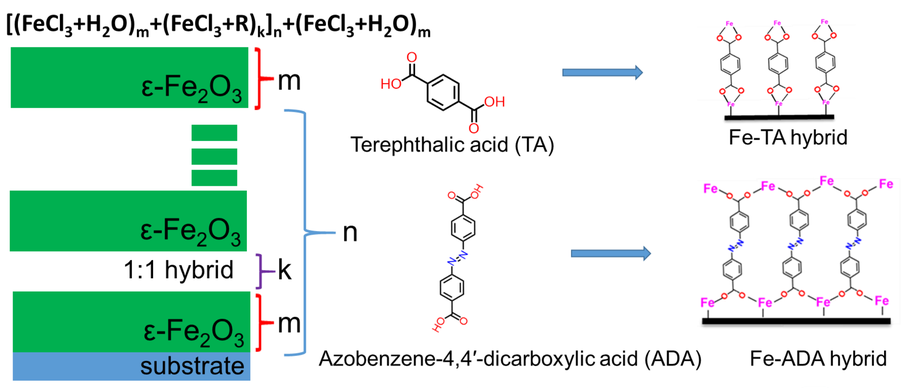
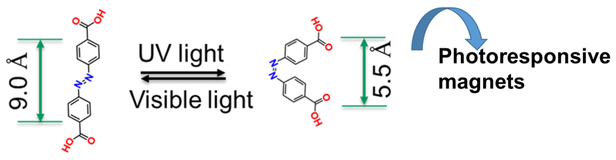
Introduction

Mechanical flexibility, low- temperature synthetic procedures, and the ability to tune properties by proper selection of organic functionalities makes organic magnets more desirable as compared to the conventional metallic, intermetallic or metal oxide magnets [1]. Herein we report a flexible, photoresponsive magnetic ε-Fe_2O_3-organic SL thin film with ε-Fe_2O_3 of certain thickness separated with monomolecular thick organic layer.

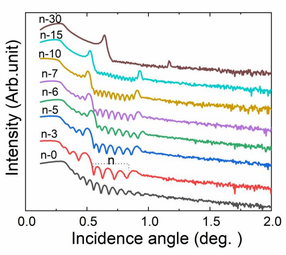
Process scheme

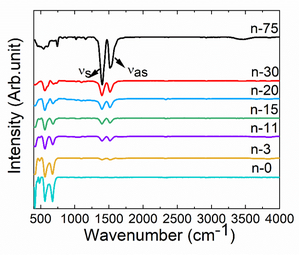


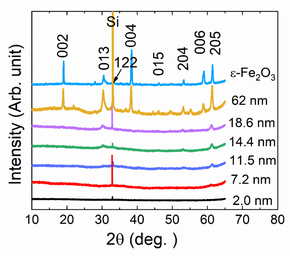


ε-Fe_2O_3-benzene magnets

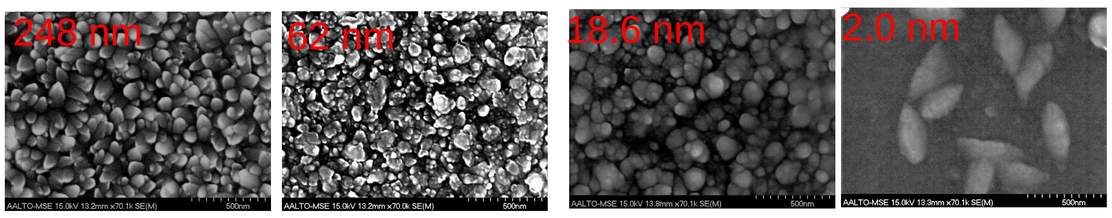
- XRR pattern confirms the intended SL structure.
- FT-IR measurement indicated a bidentate bonding (Δ =112 cm^{-1}) [2].
- XRD analysis proved the existence of ε-Fe_2O_3 in Fe-TA SL [3].



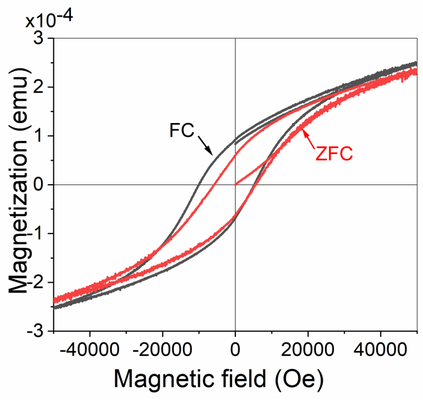




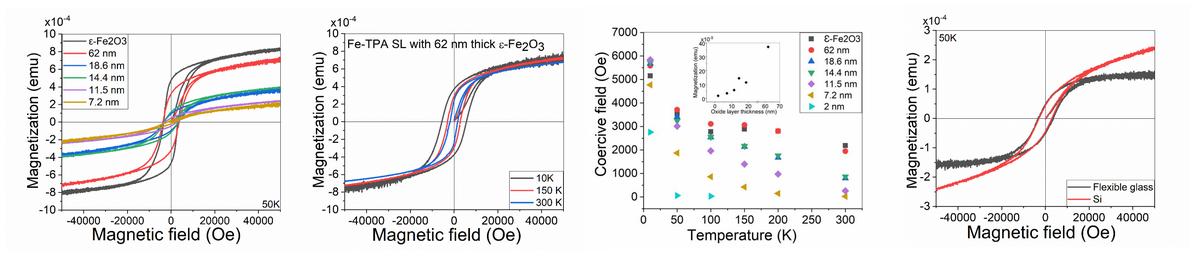
Grain size increases with decrease of individual iron oxide thickness



Probable existence of exchange bias in these samples

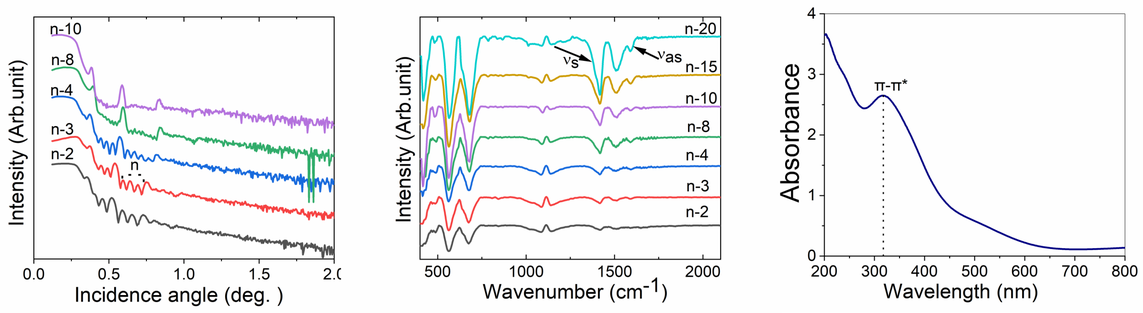


- M-H curves follows typical ferro- or ferrimagnetic hysteresis loop.
- Molecular layers influences the intrinsic magnetic properties of ε-Fe_2O_3.
- The coercive field and the magnetization increases with increase of ***m*** and decrease of ***n***.
- Coercivity decreases with increase of measurement temperature.
- Similar M-H curves for films on both Si and flexible substrates.

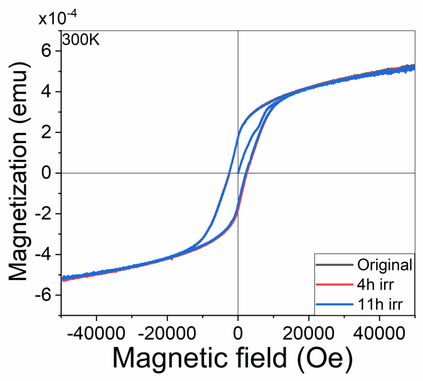


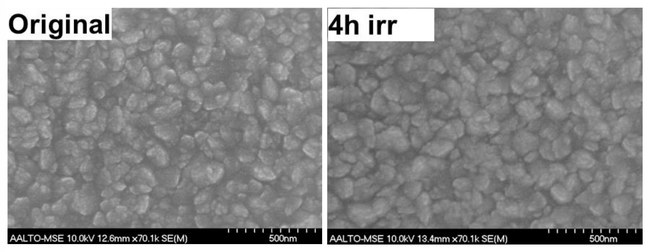
ε-Fe_2O_3-azobenzene magnets

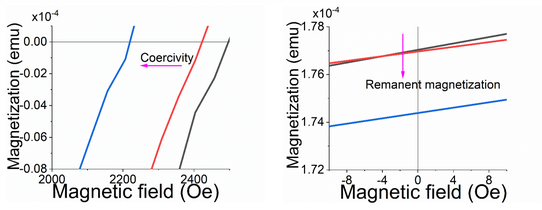
- XRR pattern confirms the targeted SL structure.
- Bridging type bonding [2] between the carboxylate anion and the metal cation (Δ =173cm^{-1}).
- The strong absorption band observed at 317 nm indicates the presence of trans isomer of azobenzene .



Photoresponsive nature affects the magnetization of these magnets upon long-time irradiation with uv light (365 nm)







Conclusions

- SL structures with precisely thickness controlled ε-Fe_2O_3 layers alternating with monomolecular organic layers.
- Flexible organic magnets with excellent coercivity and magnetization.
- Mimicking the fabrication of flexible magnetic thin film on flexible substrate.
- Utilizing the photoresponsive nature of azobenzene to create photoresponsive magnetic films.

References

1. J.S. Miller, Mater. Today **17**, 224 (2014).
2. A. Tanskanen, M. Karppinen, Sci. Rep **8**, 1 (2018).
3. M. Gich, C. Frontera, A. Roig, E. Taboada, E. Molins, H.R. Rechenberg, J.D. Ardisson, W.A.A. Macedo, C. Ritter, V. Hardy, J. Sort, V. Skumryev, J. Nogue's, Chem. Mater **18**, 3889 (2006)