Optical anisotropy of Fe_3O_4(110) investigated by Reflectance Anisotropy Spectroscopy

B. Walls[1], K. Fleischer[1], O. Lübben[1], K. Zhussupbekov[1], K. Walshe[1] and I. V. Shvets[1]

[1]School of Physics and Centre for Research on Adaptive Nanostructures and Devices (CRANN), Trinity College Dublin, Dublin 2, Ireland

Magnetite (Fe_3O_4) is an inverse spinel cubic material. Its (001) and (111) terminations have been utilised as templates for the study of nanostructure growth [1,2] and single atom and molecule absorption dynamics [2,3]. Reflectance Anisotropy Spectroscopy (RAS) probes the optical anisotropy of a material in the plane of its termination. It is ideal for studying anisotropic terminations of bulk-isotropic materials, as any response will be due to the termination and/or its influence on the bulk-like region in the vicinity of the termination. Here, we present a study of the optical anisotropy of Fe_3O_4(110). Specifically its dominant {111}-nanofaceted row reconstruction [4].

The RAS response shows a strong comparison to the first energy derivative of magnetite's dielectric function, indicating termination-induced anisotropic shifts in energy of the bulk-like optical transitions. Density Functional Theory (DFT) calculations demonstrate that this reconstruction exhibits anisotropic strain in its termination layers. The RAS response is concluded to originate from this strain. Finally, scanning tunneling spectroscopy measurements demonstrated that the reconstruction exhibits different electronic properties depending on the *in-situ* preparation conditions. X-ray photoelectron spectroscopy measurements indicate this is correlated to an altered stoichiometry and iron valency in the surface region. RAS is sensitive to this altered electronic structure, with the magnitude of the RAS response being modified.

[1] R. Bliem *et al*., *Proceedings of the National Academy of Sciences* **32**, 113 (2016)
[2] R. Bliem *et al*., *ACS Nano* **8**, 7531 (2014)
[3] K. T. Rim *et al*., *Journal of the American Chemical Society* **134**, 18979 (2012)
[4] G. S. Parkinson *et al*., *Surface Science* **649**, 120 (2016)