Towards magnetic tomography of 3D structures at the nanoscale

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With three-dimensional artificial and composite materials offering new opportunities for applications within many fields, a full structural and chemical characterization is critical for further progress. While there are a variety of complementary techniques to investigate 2D magnetism on the nanoscale, there is a need to develop new techniques to study 3D magnetic materials with a similar spatial resolution. Here I present our first results using resonant ptychographic tomography, combining quantitative hard X-ray phase imaging and resonant elastic scattering. First I will show that is possible to achieve *ab initio* element-specific 3D characterization of a cobalt-coated artificial buckyball polymer scaffold at the nanoscale. By performing ptychographic x-ray tomography at and far from the Co K edge, we are able to locate the Co layer in our sample to a 3D spatial resolution of 25 nm, and with a quantitative determination of the electron density we can determine that the Co layer is oxidized [1]. Secondly, by performing ptychographic scans with circularly polarized X-rays (hard X-ray dichroic ptychography), I will show that one can exploit X-ray magnetic circular dichroism to obtain images of the magnetic configuration of a micrometre-thick FeGd multilayer at both the Gd L_3 and the Fe K edges, demonstrating a 50 nm spatial resolution in 2D [2]. Further combination of dichroic ptychography with tomographic techniques will enable mapping of the magnetization vector field with sub-100 nm spatial resolution within micrometer-size magnetic systems.

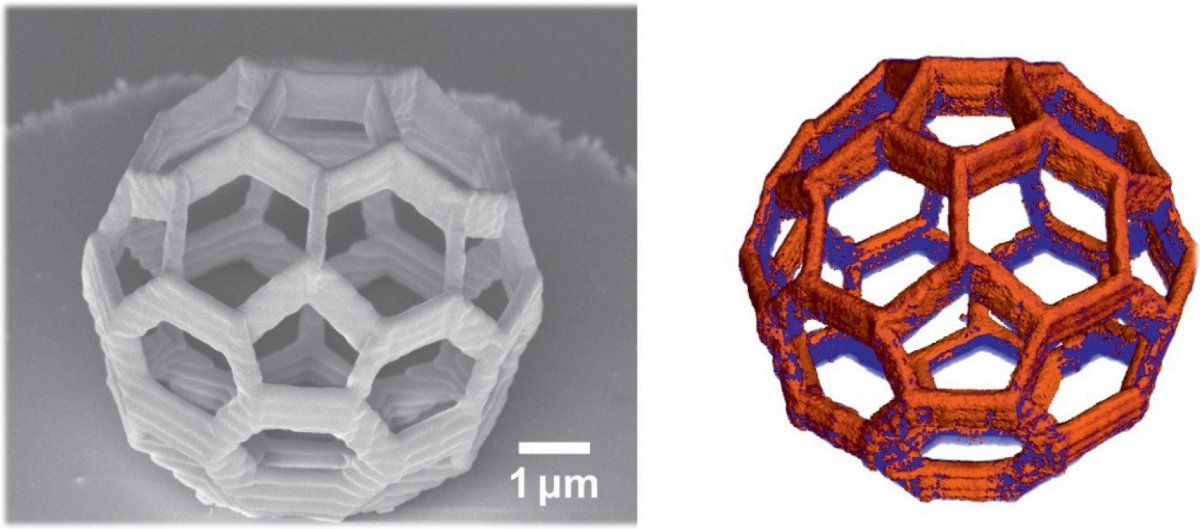

Figure 1: (right) SEM image of the cobalt-coated artificial buckyball, investigated with resonant ptychographic tomography. (left) A rendering of the element specific tomogram is shown, where the cobalt is shown in orange and the polymer resist in blue.

References

[1] C. Donnelly *et al.*, Physical Review Letters **114**, 115501 (2015).

[2] C. Donnelly *et al.*, arXiv:1603.03588v2.