Synthesis of iron oxide nanotubes using TMV as a biotemplate.

Abid Ali Khan[1], Sachin Shah[1], Wiwat Nuansing[1], Andre Chuvilin[1], Christina Wege[2], Mariana Ungureanu[3] and Alexander Michael Bittner[1,4]

[1] CIC nanoGUNE Consolider, Tolosa Hiribidea 76, 20018 Donostia – San Sebastian, Spain
[2] Institute of Biology, University of Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany
[3]CIC BiomaGUNE, Parque Tecnologico de San Sebastian, Edificio Empresarial C, Paseo Miramon 182, Donostia-San Sebastian, Spain
[4]IKERBASQUE, Basque Foundation for Science, 48011 Bilbao, Spain
a.khan@nanogune.eu

Tobacco mosaic virus (TMV) is a rod shaped plant virus containing RNA and 2100 identical coat proteins. It has a length of 300nm and a diameter 18nm [1]. TMV often aligns to linear oligomers of 600nm, 900nm, 1200nm in length. The exterior surface is highly polar and contains OH and COOH groups, the latter mainly deprotonated [2]. The synthesis of iron oxide on TMV involves simple wet chemistry under mild conditions. A mixture of aqueous Fe^{2+} and Fe^{3+} salts was used form iron oxide on the carboxylate covered exterior protein surface of TMV [3]. SEM shows plant viruses covered by a thin layer of iron oxide (5-7nm). Local EDX analysis pointed out clear peaks for Fe and O, proving the presence of iron oxide on the external protein surface.

XPS was used for a more detailed chemical analysis. In fact the iron oxide coating is a mixture of magnetite (Fe_3O_4) and maghemite (γ-Fe_2O_3). While magnetite is synthesized, it oxidizes and gives rise to maghemite on its surface. XRD showed no peaks, which could correspond to either magnetite or maghemite. Hence it is concluded that iron oxide coating on the TMV external surface is predominantly amorphous. Mineralized plant viral particles were also tested for their magnetic properties in a SQUID-VSM at 300K. The magnetic moment of mineralized TMV has a magnetization saturation of 0.00082emu/g [4,5]. However, the high coercivity value of 0.04T is due to the ferrimagnetic nature of the oxide and tubular structure of our iron oxide nanotubes [5,6].

References:

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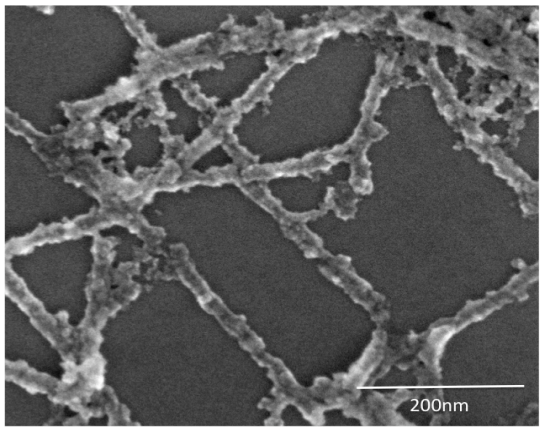

Figure 1. SEM of iron oxide-coated TMV nanotubes.

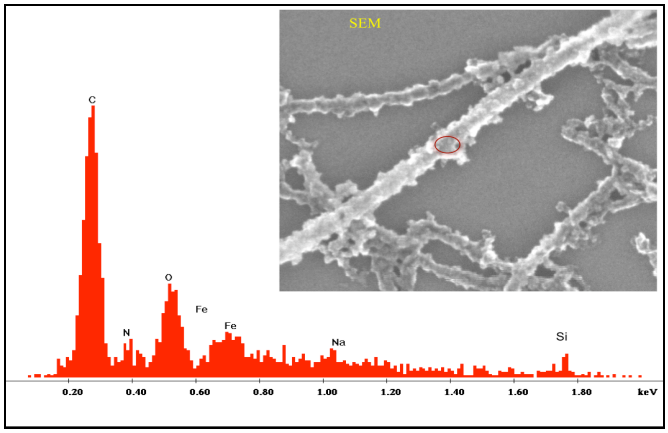

Figure 2. EDX spectrum of a single spot on iron oxide-covered TMV. Inset: SEM, spot area marked.

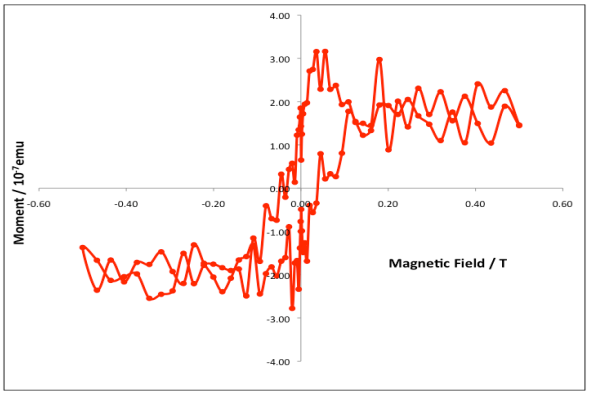

Figure 3. Magnetic field vs moment of mineralized TMV particles at 300K. Although the amount of material is very small, a ferrimagnetism hysteresis is found.