Magnetoelectric Heterostructures with Vinylidene Fluoride Oligomers

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Ferroelectric organics are attractive candidates in the investigation of magnetoelectric coupling in ferromagnetic/ferroelectric heterostructures because of their large surface charge densities and low stiffness coefficients. The latter ensure that magnetoelectric coupling effects arise solely from electric fields and not via strain coupling. We have previously shown large electric field effects on the magnetic anisotropy of thin cobalt (Co) films in heterostructures of Co with the ferroelectric copolymer P(VDF_TrFE) [1]. However, because the ferroelectric was grown ex-situ using Langmuir –Blodgett deposition, the Co/P(VDF-TrFE) interface was not pristine.

Here, we describe the thermal evaporation and characterization of a less well-known and investigated organic ferroelectric, the oligomer vinylidene fluoride (VDF) [2]. The high surface charge density and the ability to perform vacuum deposition of the oligomer make it highly suitable for magnetoelectric investigations. We report on structural characterization, the effects of annealing, macroscopic and microscopic ferroelectric polarization, hysteresis loops, and the transition temperature [3]. We also performed in-depth investigations of the Co/VDF interface, showing that the interface remains pristine for many days and that VDF provides excellent protective coverage of the Co [4]. Finally we report on magnetoelectric coupling between Co and VDF, both with and without a dielectric layer sandwiched between the two.

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References:

1.A. Mardana, S. Ducharme and S. Adenwalla, Nano Lett. **11**, 3862 (2011).

2. K. Foreman, C. Labedz, M. Shearer and S. Adenwalla, Rev. Sci. Instrum. **85**, 043902 (2014).

3. K. Foreman, N. Hong, C. Labedz, M. Shearer, S. Ducharme and S. Adenwalla, J. Phys. D: Appl. Phys. **49**, 015301 (2016).

4. K. Foreman, E. Echeverria, M. A. Koten, R. M. Lindsay, N. Hong, J. Shield and S. Adenwalla, Mater. Res. Express **3**, 116403 (2016).