Microwave Magnetization Dynamics in Room Temperature Organic-Based Magnets: From Fundamental Studies to Emerging Applications

M. Chilcote[a], A. Franson[a], M. Harberts[a], Yu Lu[a], Howard Yu[a], Na Zhu[c], I. Froning[a], Xufeng Zhang[c], R. Adur[a], P.C. Hammel[a], A.J. Epstein[a,f], M. Flatté[e], Hong Tang[c,d], and E. Johnston-Halperin[a,b]

[a] *Department of Physics, The Ohio State University, Columbus OH, USA*
[b] *Chemical Physics Program, The Ohio State University, Columbus OH, USA*
[c] *Department of Electrical Engineering, Yale University, New Haven CT, USA*
[d] *Department of Physics and Applied Physics, Yale University, New Haven CT,*
[e] *Department of Physics, University of Iowa, Iowa City IA, USA*
[f] *Department of Chemistry, The Ohio State University, Columbus OH, USA*

Organic and organic-based materials are attractive candidates for applications in magnetoelectronics and spintronics due to their low cost, ease of fabrication, and low spin-orbit coupling (and consequently long spin lifetimes). More recently, advances in these fields have highlighted the potential for dynamic excitations to drive new phenomena such as ferromagnetic resonance generated spin-pumping. Here we present a series of recent breakthroughs in the synthesis, encapsulation, and measurement of organic-based magnets that lay the foundation for all organic magnetoelectronic and spintronic devices. We will discuss advances in encapsulation strategies that allow lifetimes of up to 1 month in air [1], the use of ligand substitution to generate a library of related magnetic materials [2], the growth of all-organic and hybrid organic/inorganic magnetic heterostructures, and measurements of ferromagnetic resonance (FMR) linewidths of ~ 1 Oe [3], comparable to yttrium iron garnet (YIG). Finally, we demonstrate the potential for real world applications in the construction of a $V[TCNE]_2$ based spin-wave resonance device with spectral tuning from 1 – 5 GHz and a quality factor in excess of 3,200 that operates under ambient conditions [4]. These results establish the validity of organic-based magnets for applications in next-generation magnetoelectronics and provide unique leverage on long-standing challenges in the field of organic spintronics.

[+] Author for correspondence: johnston-halperin.1@osu.edu

[1] H. Froning, M. Harberts, Y. Lu, H. Yu, A. J. Epstein and E. Johnston-Halperin, Appl. Phys. Lett **106**, 122403 (2015).

[2] Yu Lu, Howard Yu, Megan Harberts, Arthur J. Epstein and Ezekiel Johnston-Halperin, RSC Advances **5**, 82271-82275 (2015); Yu Lu, Howard Yu, Megan Harberts, Arthur J. Epstein and Ezekiel Johnston-Halperin, J. Mat. Chem. C **3** (28), 7363-7369 (2015).

[3]H. Yu, M. Harberts, R. Adur, Y. Lu, P.C. Hammel, E. Johnston-Halperin and A.J. Epstein, Appl. Phys. Lett. **105**, 012407 (2014).

[4] Na Zhu, Xufeng Zhang, I.H. Froning, Michael E. Flatté, E. Johnston-Halperin, and Hong X. Tang Appl. Phys. Lett. **109**, 082402 (2016).