

Molecular Engineering of Crystalline Nano-optomechanical Transducers

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Abstract

Crystalline materials that behave as optical actuators and proceed via some form of nano-optomechanical mechanism are of particular interest for optical data storage[1] or quantum computing[2]. Nonetheless, the field is facing a dearth of suitable functional materials for applications. One possible material option is a series of compounds based on the generic formula, $[\text{Ru}(\text{SO}_2)(\text{NH}_3)_4\text{X}]\text{Y}$, whose SO_2 group manifests solid-state linkage photo-isomerization (X is the *trans*-ligand to SO_2 ; Y is a counterion). This light-induced phenomenon causes these materials to act as photo-induced molecular switches [3-5] or molecular transducers [6,7] whose nano-optomechanical properties exist in the single-crystal state: a high-quality solid-state medium for single-photon control.

This talk will present the development of this family of materials towards such applications, via a range of advanced *in situ* 'photo-crystallography' and *in-situ* imaging experiments that capture the phenomenon in their light-induced state [8-10]. Results are enabling our understanding of the light-induced molecular structure and nano-optomechanical properties of these light-induced solid-state actuators. Establishing this knowledge-base of structure-to-function relationships leads to the ultimate goal of being able to molecularly engineer these materials for a given device application.

References

- [1] J. M. Cole, *Zeit. fuer Krist.* 223 (2008) 363.
- [2] J. Boschmann, A. Veinsencher, D. D. Awschalom, A. N. Cleland, *Nature Physics*, 9 (2013) 712.
- [3] J. M. Cole et al, *Chem. Commun.* (2006) 2448.
- [4] A. E. Phillips, J. M. Cole, T. d'Almeida, K. S. Low, *Phys. Rev. B* 82 (2010) 155118.
- [5] A. E. Phillips, J. M. Cole, T. d'Almeida, K. S. Low, *Inorg Chem* 51 (2012) 1204.
- [6] S. O. Sylvester, J. M. Cole, *Advanced Materials* 25 (2013) 3324.
- [7] S. O. Sylvester, J. M. Cole, P. G. Waddell, *J. Am. Chem. Soc.* 134 (2012) 11860.
- [8] J. M. Cole, *Chem. Soc. Rev.* 33 (2004) 501.
- [9] J. M. Cole, *Acta Crystallogr. A* 64 (2008) 259.
- [10] J. M. Cole, *The Analyst*, 136 (2011) 448.