Microscopic visualization of contacts and friction

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The precise measurement of contact area and friction forces on the molecular scale is a highly desired tool in contact mechanics.[1] Understanding this might lead us to the new era of single-molecule motors controlled friction. Molecular rotors such as compound **1** (Fig. 1),[2] which are extremely sensitive to viscosity change and confinement were designed in our lab and made the first direct microscopic visualization of contact possible.[3] The increased fluorescence intensity of the molecules is used to mark the contact area. Other photophysical properties (lifetime, spectral shift): Fig.2,3, indicate the presence of solvent within the pixel size of the image, which suggests that the real contact formed by asperities is actually smaller than the diffraction limited spot. In order to test this we are now developing TIRF microscopy and photoswitchable fluorophores for super-resolution contact area imaging in the xy-plane.

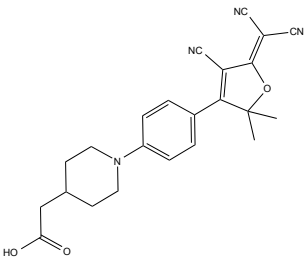

Figure 1. The viscosity sensitive compound

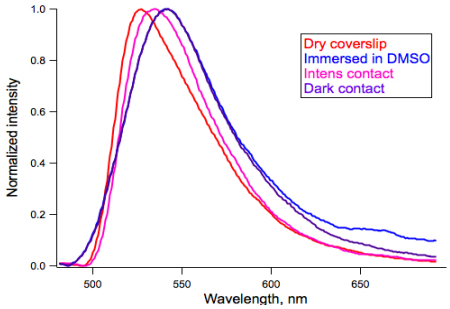

Figure 2. Spectra of the compound 1 immobilized on coverslide in contact with PMMA bead and immersed in solvent.

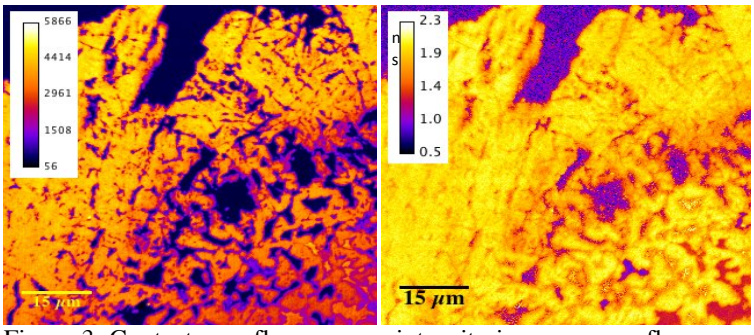

Figure 3. Contact area fluorescence intensity image versus fluorescence lifetime image between PMMA bead and the glass coverslip with a monolayer of compound 1. Relatively short lifetimes in the "dark contact" regions indicate presence of the solvent in the area.

For super-resolution in the axial direction and 3D imaging we are investigating newly synthesized low viscosity fluorescent liquids: Fig. 4,5.[4]

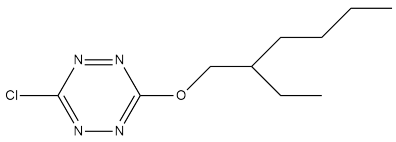

Figure 4. Fluorescent liquid

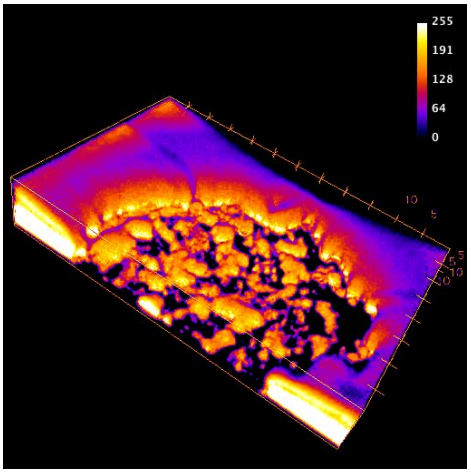

Figure 5. The contact area 3D image between PS bead and the glass coverslip. Size 80 × 80 μm.

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References:

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[4] C. Allain et al., *ACS Appl. Mater. Interfaces,* **2016**, 8, 19843−19846.