Fluorescent Molecular Rotors: From Working Principles to Visualization of Mechanical Contacts.
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SUMMARY:

In this thesis, we develop and characterize a method that enables us to visualize the real microscopic contact area between objects, using fluorescent molecules. Visualization and the ability to predict the real contact area between touching objects is a subject of considerable interest, because the real contact area plays an important role in friction. In this thesis, a method that enables us to visualize mechanical contacts by using fluorescent molecular rotors is described, and photophysical characterization of such molecules is examined in detail by means of steady-state, time-resolved fluorescence and transient spectroscopy techniques.

To visualize the real contact area between solid surfaces, we developed a method based on fluorescent molecular rotors immobilized on a solid glass substrate. Fluorescent molecular rotors are weakly fluorescent in low-viscosity solvents, because internal rotational motions result in a rapid decay of the excited state, such that the emission of a fluorescence photon is not fast enough to compete effectively. In high viscosity liquids and polymer matrices, however, such motions become severely hindered. Therefore, the molecules can remain in the excited state much longer, and become strongly fluorescent. A similar situation arises when molecular rotors are confined in contacts between objects, and this effect can be imaged and used to measure the real contact area with fluorescence microscopy.