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Imaging and controlling intracellular reactions: Lysosome transport as a function of diameter and the intracellular synthesis of conducting polymers

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Eukaryotic cells are the ultimate complex environment with intracellular chemical reactions regulated by the local cellular environment. For example, reactants are sequestered into specific organelles to control local concentration and pH, motor proteins transport reactants within the cell, and intracellular vesicles undergo fusion to bring reactants together. Current research in the Payne Lab in the School of Chemistry and Biochemistry at Georgia Tech is aimed at understanding and utilizing this complex environment to control intracellular chemical reactions. This will be illustrated using two examples, intracellular transport as a function of organelle diameter and the intracellular synthesis of conducting polymers. Using single particle tracking fluorescence microscopy, we measured the intracellular transport of lysosomes, membrane-bound organelles, as a function of diameter as they underwent transport in living cells. Both ATP-dependent active transport and diffusion were examined. As expected, diffusion scales with the diameter of the lysosome. However, active transport is unaffected suggesting that motor proteins are insensitive to cytosolic drag. In a second example, we utilize intracellular complexity, specifically the distinct micro-environments of different organelles, to carry out chemical reactions. We show that catalase, found in the peroxisomes of cells, can be used to catalyze the polymerization of the conducting polymer PEDOT:PSS. More importantly, we have found that a range of iron-containing biomolecules are suitable catalysts with different iron-containing biomolecules leading to different polymer properties. These experiments illustrate the advantage of intracellular complexity for the synthesis of novel materials.