PRF#: 56315-ND4
Project Title: Organic Chemistry Studies in Solution via Single-Molecule Fluorescence Microscopy
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Goals

Single-molecule fluorescence microscopy techniques have emerged in the last nine years as powerful tools for studying organic chemistry and catalysis on surfaces—but not in freely diffusing solution phases. Many of these examples, while groundbreaking, have limited relevance to current mechanistic questions in solution-phase organic chemistry. Motivated by the importance of chemistry that occurs in the solution phase, we herein aim to develop and demonstrate a new technique for imaging the chemistry of freely diffusing molecules using single-molecule fluorescence microscopy. This technique will provide insight into chemical reaction mechanisms by avoiding the ensemble averaging that obscures certain reactivity information in traditional measurements.

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Move of collaborator: 1.5-year slow-down on instrument access. Our collaborator, Prof. Dr. Thorben Cordes, moved his laboratory from the University of Groningen to the Ludwig Maximilian University of Munich (LMU). This process has resulted in dismantling and rebuilding of the home-built fluorescence microscopy laser system that we intended to use together for part of this collaboration. Thus, we were unable to initiate collaborative experiments on this part of the project on the timeline expected. This instrument has 3D scanning skills that our in-house/-lab microscope does not, making finding interfaces in solution possible. The instrument is expected to be rebuilt at its new location in 2018. Further, we have identified a new collaborator, Prof. Kevin Welcher at Duke University, with an instrument suitable for furthering the research in this grant. For these reasons, we anticipate that our approved no cost time extension for the grant funding will enable studies to move forward.

Alternative approaches. Due to the unavailability of the expected equipment, we have pursued three alternative approaches with our in-house microscope, the first two of which were detailed in last year's annual report in 2017, and the third of which was continued during the period covered by the current 2018 annual report:

1) Use of viscous solvents to slow diffusion, coupled with use of our in-house microscope and a microscope capable of single-particle tracking in a shared-use facility, the UCI Laboratory for Fluorescence Dynamics (LFD). This approach was ultimately not successful.

2) Use of catalysts dispersed in a gel in order to slow diffusion. As PI, Prof. Blum was in the laboratory during summer 2017 herself and performed gel dispersion experiments in order to assist the project. This approach was ultimately not successful.

3) Additional experiments using diffusing polymers are underway. These experiments were continued by postdoctoral scholar Dr. Nozomi Saito during the current reporting period, and are ongoing in the laboratory currently.

Plan for next project period. As mentioned, the ACS-PRF approved a no cost time extension on account of the laboratory move by the collaborator. The original collaborator anticipates that the instrument will be available starting late 2018. In addition, we have identified a new collaborator, Prof. Kevin Welcher at Duke University. Graduate student Antonio Garcia IV will be traveling to Duke to initiate these experiments in September 2018.