Dynamic behavior of swarm microtubules driven by kinesins

Arif Md. Rashedul Kabir[1], Tamanna Ishrat Farhana[2], Daisuke Inoue[1], Kazuki Sada[1,2], and Akira Kakugo[1,2]

([1]Faculty of Science, Hokkaido University; [2]Graduate School of Chemical Sciences and Engineering, Hokkaido University)

【Introduction】

Collective motion is a fascinating example of coordinated behavior of self-propelled objects, which is often associated with the formation of large scale patterns. Nowadays, in vitro gliding assay is being considered a model system to experimentally investigate various aspects of group behavior and pattern formation by self-propelled objects. In this work, we have demonstrated the collective motion of kinesin driven microtubules by regulating mutual interaction among the gliding microtubules, by employing depletion force among them.[1] Proper regulation of the mutual interaction among the gliding microtubules through employment of the depletion force was found to allow the exhibition of collective motion and stream pattern formation by microtubules. We also discuss how collectively moving microtubule on kinesin coated elastomer substrate response to external stimuli such as mechanical stresses.

【Results and Discussion】

By employing a macromolecule (methylcellulose) induced depletion force, we demonstrated the first-ever collective motion and stream pattern formation by microtubules on a kinesin coated surface. This method offers a simple and universal technique to investigate the coordinated behavior of self-propelled objects using biomolecular motor systems. Consequently, this will be helpful in understanding not only the collective behavior of self-propelled objects such as birds, animals or fishes, but also may provide new insight into emergent structures obtained through a non-equilibrium process. Recently microtubule/kinesin system has attracted attention in the field of molecular robotics as the smallest self-propelled objects. Molecular robots, relying on a large number of collectively moving self-propelled objects such as gliding microtubules, enables parallel processing in transporting a large number of small cargos and assembling building blocks into an ordered structure. Therefore, ideas obtained from the present study on collective motion of gliding microtubules are expected to expand the boundaries in the field of molecular robotics.

【References】

(1) Inoue et. al., *Nanoscale, 7*, 18054-18061, (2015).