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Structure and dynamics of polymer materials at the single molecule scale studied by novel fluorescence microscopy techniques

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Polymer materials have been widely used in various scenes of our daily life because the polymers show unique physical properties. The origin of the polymer materials is the large entropy of a single molecule, which has a long chain-like structure with a large molecular weight. Therefore, the conformation of the single polymer chain has been the key problem in polymer physics. However, because the single polymer chain, show great complexity in the structure and molecular motion due to its large degree of freedom for the molecular structure, it has been difficult to obtain the direct information on the single chain by the conventional experimental techniques. In this talk, the author will present the novel methodology to examine the structure and dynamics of the single chain in a polymer material. In a bulk polymer material, a polymer chain takes a random coil conformation expanded in three dimensions and entangled with the surrounding chains. In order to extract the information from a single chain, it should be labeled by a fluorescent moiety. However, the conventional fluorescence microscopy does not have the high resolution to observe the single polymer chain. Recent development of super-resolution microscopy allows the fluorescence imaging with the spatial resolution on the order of 10 nm. The author has introduced this technique for the structural analysis of polymer materials. The fluorescence labeling of poly(methyl methacrylate) chain with a photo-switchable rhodamine dye and the astigmatic detection optics enabled the three-dimensional analysis of the chain conformation. The super-resolution microscopy revealed the molecular behavior in the macroscopic deformation process.

Biography

Hiroyuki Aoki is a Senior Scientist in Materials and Life Science division, J-PARC Center, Japan Atomic Energy Agency. He obtained his degrees of BE, ME and PhD from Kyoto University in 1996, 1998 and 2001, respectively. He became an Assistant Professor of Department of Polymer Chemistry, Kyoto University in 2001 and was promoted to Associate Professor in 2006. In 2016, he moved to J-PARC as a Senior Scientist. His research interests are focused on structure and dynamics of polymer materials at the single molecule scale. He was awarded with the Inoue Research Award for Young Scientist from Inoue Foundation for Science (2002), Young Scientist Lectureship Award (2008), SPSJ Award for the Outstanding Paper in Polymer Journal (2008), and SPSJ Science Award from the Society of Polymer Chemistry, Japan (2016)

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