Hiroyuki Aoki, J Material Sci Eng 2018, Volume 7
DOI: 10.4172/2169-0022-C8-113

Segmental dynamics in a polymer material studied by single molecule imaging

Hiroyuki Aoki
Japan Atomic Energy Agency, Japan

Polymer materials have been used widely in our daily life, and they are used often as an ultra thin film with a thickness less than 100 nm. Such the thickness is comparable to the size of a single polymer chain; therefore, the conformation and molecular motion in an ultra-thin film should be constrained. Becuase the unique properties of polymer materials originate from the large degree of freedom of a polymer chain, various properties of an ultra-thin film would be different from those in a bulk state. However, the details on the polymer dynamics in a confined space is still unclear because the limitation of experimental methods. In this work, the dynamics in polymer thin films was studied through single molecule observation. A fluorescent perylenediimide (PDI) molecule was incorporated at the center of a poly(alkyl methacrylate) chain for the selective observation of the segmental motion at the chain center. The emission from the PDI moiety was observed by fluorescence microscopy in a defocus condition, which probe the translational and orientational motion of a single fluorescent molecule in real time. The detailed analysis of the molecular motion revealed that the diffusion rate of the in-plane rotation was similar for the thin film and the bulk; on the other hand, the out-of-plane motion was restricted in a thin film. This result indicates that the spatial restriction in an ultra-thin film thinner than the unperturbed chain dimension alters the dynamics of individual molecules in a polymer system.

Recent Publications

1. Aoki H, Mori K, Ito S (2012) Conformational analysis of single polymer chains in three dimensions by super-resolution fluorescence microscopy. Soft Matter 8: 4930–4935.
2. Aoki H, Takahashi T, Tamai Y, Sekine R, Aoki S, Tani K, Ito S (2009) Poly(methacrylate)s Labeled by Perylene Diimide: Synthesis and Applications in Single Chain Detection Studies. Polym. J. 41: 778–783.
3. Ube T, Aoki H, Ito S, Horinaka J, Takigawa T, Masuda T (2009) Affine deformation of single polymer chain in poly(methyl methacrylate) films under uniaxial extension observed by scanning near-field optical microscopy. Polymer 50: 3016–3021.
4. Ube T, Aoki H, Ito S, Horinaka J, Takigawa T, Masuda T (2011) Relaxation of Single Polymer Chain in Poly(methyl methacrylate) Films under Uniaxial Extension Observed by Scanning Near-Field Optical Microscopy. Macromolecules 44: 4445–4451
5. Ube T, Aoki H, Ito S, Horinaka J, Takigawa T (2012) Relaxation of single polymer chain in binary molecular weight blends observed by scanning near-field optical microscopy. Soft Matter 8: 5603–5611.

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 promoted to an 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 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 Society of Polymer Chemistry, Japan (2016).

hiroyuki.aoki@j-parc.jp