Characterization of Polymeric Nanostructures by Time-Resolved Fluorescence Microscopy

Holger Schönherr

University of Siegen, Department of Chemistry - Biology & Research Center of Micro and Nanochemistry and (Bio)Technology (Cµ), Adolf Reichwein Str. 2, 57076 Siegen

E-mail: schoenherr@chemie.uni-siegen.de

In this contribution the nanoscale characterization of different polymeric nanostructures ranging from polymer stabilized nanocapsules and polymersomes to uniform as well as gradient polymer brushes [1] using time-resolved fluorescence microscopy (fluorescence lifetime imaging microscopy, FLIM) will be discussed [2]. While advanced electron and scanning probe microscopy methods allow one to image and analyze various kinds of polymeric nanostructures and to unveil some properties and details down to the nanoscale, the use of molecular probes provides complementary and highly localized information. The dependence of the fluorescence lifetime τ of incorporated tracer dyes on local polymer properties, such as dielectric constant or polarity, is highly sensitive and can be exploited to determine these properties and also to map any heterogeneities [3]. For instance, the localization of the fluorophore in different nanoenvironments, resulting in different values of τ, as well as their concentration can be assessed [4,5]. Finally, the combination of this confocal fluorescence method with atomic force microscopy (AFM) provides access to topography as well as mechanical property determination [2]. Values of τ are obtained by time-correlated single photon counting (TCSPC), which relies on the accurate time measurement of single photon events, utilizing a pulsed laser for excitation and a single photon detector. Using these methods new insight into water penetration into polymer thin films in the context of dynamic wetting of flexible, adaptive, and switchable surfaces as well as stimulus-responsive polymer brush architectures is afforded.

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