GRAPHENE-BASED DYES AS STABLE, HIGH-BRIGHTNESS PROBES FOR SUPER-RESOLUTION MICROSCOPY

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. In single-molecule localization microscopy (SMLM), two classes of chromophores exist: organic dyes and inorganic quantum dots (QDs). While effective, both probes have limitations. For instance, the photo-switching behavior of organic dyes is strongly dependent on buffer conditions, making it challenging to perform high-quality imaging in all environments. For QDs, the large size (~ 10 nm) and broadband excitation spectrum, nearly reaching into the emission band, limit their performance as reliable molecular probes and their optical switching properties.

In this work, we report a new class of probes for SMLM (and general fluorescence): atomically precise graphene quantum dots (GQDs). The use of GQDs resolves the buffer stability challenges of dyes, as well as the size and spectral limitations of traditional QDs. GQDs are prepared through bottom-up chemical synthesis, and constitute a hybrid of an organic dye and QD, having an atomically defined graphene structures. Our experiments show that GQDs have outstanding physicochemical properties for SMLM: 1) small size, ~1nm, 2) ultra-stable optical switching properties that are environment-independent, and 3) narrow excitation and emission spectra – even compared to organic dyes. Moreover, GQDs show high brightness and an low on-off duty cycle comparable to that of Alexa 647, the current gold standard organic dye for SMLM, which emits ~5200 photons / switching event, suggesting that GQDs are considerably more favorable for SMLM. Finally, we demonstrate the versatility of GQDs for super-resolution microscopy by imaging fabricated nanostructures. Currently, bio-imaging experiments with such GQDs are carrying on.