Special Lecture (Material Science, Chemistry, TREMS)

7th Feb.(Fri) 2020, 16h00-17h30
Room 107, Lab. of Adv. Res. B（総合研究棟 B）, Univ. Tsukuba

Synthesis and properties of graphene related materials: Graphene oxide and Graphene nanoparticles

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The rapid rise of 2-dimensional nanomaterials implies the development of new versatile, high-resolution visualization and placement techniques. For example a single graphene layer becomes observable on Si/SiO_2 substrates by optical microscopy because of interference effects when the thickness of silicon oxide is optimized.[1,2] However, differentiating monolayers from bilayers remains challenging and advanced techniques like Raman mapping, atomic force microscopy (AFM) or scanning electron microscopy (SEM) are more suitable to observe graphene monolayers. The two first are slow and the third one is operated in vacuum so that in all cases real-time experiments including notably chemical modifications are not accessible. Here, we introduce a new wide-field optical microscopy technique: Backside Absorbing Layer Microscopy (BALM), which uses Anti-Reflection and Absorbing (ARA) layers to achieve extreme contrast at an interface.[3] It combines the vertical *sub*-nm sensitivity of an AFM with the versatility and real-time imaging capabilities of an optical microscope. We demonstrate that this technique allows imaging very easily 2D materials like graphene oxide and MoS_2, both in air and in water, with extremely high resolution.

Despite its outstanding electronic, optical and mechanical properties, the use of graphene for real-world applications is severely limited because of its semi-metallic character. It is well known that when a material is reduced to nanoscale dimensions, the electronic confinement induces original size-dependent properties. For the last decade, a great attention has been paid to the size reduction of graphene using conventional "top-down" approaches (lithography and etching, thermal treatments and oxidation of bulk materials) to fabricate graphene quantum dots (GQDs)[4] or graphene nanoribbons (GNRs).[5] However, the "top-down" approaches do not allow a sufficient control of the structure of the material and of the oxidation state of the edges, which drastically impact the properties. In order to truly control, with the required level of precision, the morphology and the composition of the materials and of its edges, the bottom-up approach is the relevant way to proceed.[6,7] Here, I'll present the "bottom-up" synthesis of graphene quatum dots and the first investigation of the photoluminescence (PL) properties of at the single molecular-scale. The GQDs exhibited emission of single photons at room temperature with high brightness and purity.[8]

References

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