Atomic level imaging and spectroscopy of nano materials

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High-resolution transmission electron microscopy (HRTEM) plays an important role to characterize atomic structures of carbon-based materials. Recently, it has been demonstrated that the motional behaviors of single molecules can be characterized by HRTEM [1, 2]. The bimolecular reactions of fullerene and metallo fullerene molecules in carbon nanotube were studied by TEM, proving that the atomic resolution imaging of chemical reaction is indeed possible with moderate experimental conditions [3]. More recent advances is found in scanning transmission electron microscopy combined with electron energy-loss spectroscopy (STEM-EELS) on the basis of single atomic imaging and spectroscopy, unveiling intrinsic electronic states of edge atoms in graphene [4] and modulated electronic states of nitrogen atom adjacent to a boron vacancy in hexagonal boron nitride (h-BN) [5]. Although it has been believed impossible, we have provided enough evidences of ultimate single atomic analysis. The topic may cover some of the advantages in the instrumentations: small and bright electron probe and less damage system, attained by newly developed aberration correctors operated at low voltage (30 - 60 eV).

A part of the study is supported by Kakenhi from MEXT (23681026 and 22000008), JST-Kenkyu Kasoku, and JST-S-innovation.

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