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Anderson localization of graphene by helium ion irradiation

SHINICHI OGAWA*, **YUICHI NAITOU**

Nanoelectronics Research Institute, National Institute of Advanced Industrial Science and Technology (AIST), *Tsukuba, Ibaraki, 305-8569, Japan*
*e-mail: ogawa.shinichi@aist.go.jp

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Graphene has been the subject of intensive research for its unique physical properties. Recently, tuning the electrical properties of graphene by irradiating it with an ion beam or exposing it to a reactive gas atmosphere has been of great interest. [1,2] The basic idea is to generate defects by using accelerated ion beam bombardment or reactive gas treatment and then to introduce localized states around the charge neutral point of graphene. Such localized states govern the transport properties of graphene, and highly defective graphene as a transition into a two-dimensional Anderson insulator is theoretically predicted. [3]

Irradiation of a single-layer graphene (SLG) with accelerated helium ions (He^+) by helium ion microscopy (HIM) controllably generates defect distributions, which create a charge carrier scattering source within the SLG. We report direct experimental observation of metal-insulator transition in SLG on SiO_2/Si substrates induced by Anderson localization. This transition was investigated using scanning capacitance microscopy by monitoring the He^+ dose conditions on the SLG. The experimental data show that a defect density of more than ~1.2% induced Anderson localization. We also investigated the localization length by determining patterned placement of the defects and estimated the length to be several dozen nanometers—no fewer than 20 nm and no more than 50 nm. These findings provide valuable insight for direct-patterning and designing graphene-based nanostructures using HIM. Further detail will be presented. [4-6]

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