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表面波プラズマCVDによるポリイミド基板上へのグラフェンシート低温合成
Low Temperature Synthesis of Graphene-sheets on Polyimide Substrate by Surface-wave Plasma CVD

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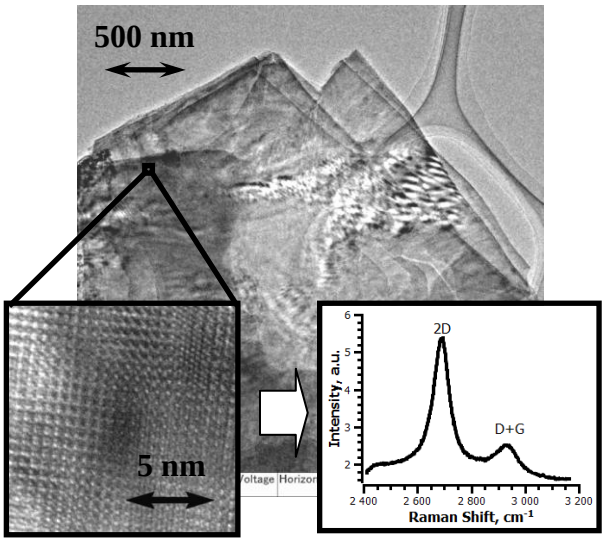
Carbon nanotubes (CNTs) and graphene are very attractive materials with extraordinary properties and different potential applications. However, to apply carbon nanomaterials (CNMs) in the real devices it is necessary to develop methods of large-scale synthesis at low temperature where the structure and chemical composition of the substrates remain undamaged. One of the most promising methods to achieve this goal is plasma-enhanced chemical vapor deposition (PECVD) (*1*).

We have recently demonstrated the possibility of low-temperature growth of carbon nanotubes and few-layered graphene sheets onto silicon and polyimide substrates (*2*) by microwave-excited surface wave plasma CVD device. To grow the multilayered graphene sheets we used graphite-encapsulated metal nanoparticles (*3*) as catalyst and applied two-stage treatment. At the first stage we used ammonia plasma to make catalyst active and then we treated the samples by ammonia/methane microwave plasma to realize a CNMs growth. In this work we pay attention to origin of the low temperature growth of graphene sheets obtained by referred method. We tried to understand the mechanism of graphene growth by changing the most important parameters of synthesis such as treatment time, gas flow mixtures, bias voltages, nature of substrates etc. We found that all of them can greatly effect on the structure of growing CNMs.

The results of these investigations will be presented at the conference in details.



HRTEM picture and typical Raman spectrum of multilayered graphene sheets obtained onto the polyimide substrates (2)

1. S. Hofmann, C. Ducati, J. Robertson, B. Kleinsorge, *Applied Physics Letters* **83**, 135 (2003).

2. R. V. Bekarevich, S. Miura, A. Ogino, A. V. Rogachev, M. Nagatsu, *Journal of Photopolymer Science and Technology* **25**, 545–549 (2012).

3. M. Nagatsu *et al.*, *Carbon* **44**, 3336–3341 (2006).