**Secondary Electron Emission from Multi-layer Graphene by TDDFT Simulations**

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Scanning Electron Microscopy (SEM) that observes secondary electron emission (SEE) has great achievements in surface science. However, the physical interpretation of SEM images, especially, of atomic sheets such as graphene is not clear. Some experiments comparing the amount of SEs before and after coating graphene on the substrates have been reported, and it has been found that graphene coating decreases the amount of SEs[1-3]. However, the mechanism of SEE from graphene itself is totally unkown because it is difficult to distuinguish experimantaly SEE of the graphene from that of the substrates. Therefore, a theoretical study of SEE from graphene is worth doing for clarifying the underlying mechanism of SEE leading to the SEM images.

A time-dependent density functional theory (TDDFT) simulation in real time has been successfully applied to electron wave-packet scattering by graphene in our previous studies[4-7]. The present TDDFT study enables a fully dynamic description of both the target and incident electrons, which is necessary for modeling nanostructures. Compared with the conventional scattering theory, the TDDFT method has an advantage in that multiple and inelastic scatterings are *automatically* included in the simulations.

In this study, we investigated SEE of multi-layer graphene (MLG) by the TDDFT simulations, and determined the incident energy dependence and the layer-number dependence of SEs from MLG. The amount of SEs tends to converge to a certain value with the increase of the number of layers, especialy, upon low-energy (< 200 eV) electron impact. The convergence originates from attenuation of incident electron and relationship between the amount of bound excited electrons and total excited electrons[8]. Finally, we determined the SEE of bulk graphite that is comaparable to the experiment[9].

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