Overlapped Grain Boundary Effect on the Electrical Properties of Polycrystalline Graphene

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Overlapped grain boundary is one of characteristic features of 2D materials, which could hardly be observed in thin films of 3D materials. It has been reported that overlapped grain boundaries were prevalently formed during the growth of 2D materials, such as graphene and MoS_2[1,2]. In these cases, overlapped grain boundaries could improve the electrical properties by bridging the crystalline grains. Furthermore, the formation mechanism of overlapped grain boundaries was recently suggested[3]. It proposed a possibility to control the formation of overlapped grain boundaries during the growth process. Although several studies explained the sheet resistance of graphene[4,5], the concept of overlapped grain boundary has not been considered in previous sheet resistance models.

We investigate the effect of overlapped grain boundaries on the sheet resistance of graphene. According to our model treating the grain boundaries explicitly, the existence of overlapped grain boundaries decreased the sheet resistance in small grain regime rather than large grain regime. These results also imply that overlapped grain boundaries increase the variation of sheet resistance in polycrystalline graphene compared with 3D thin film model under the same growth conditions.

References

[1] Adam W. Tsen et al., Science, 6085 (2012) 1143-1146
[2] Sina Najmaei et al., Nature materials, 8 (2013) 754-759
[3] Jichen Dong et al., Chemical Science, Advance Article (2017) doi:10.1039/c6sc04535a
[4] Dinh Loc Duong et al., Nature, 7419 (2012) 235-239
[5] Andreas Isacsson et al., 2D Materials, 4 (2016) 012002

Figures

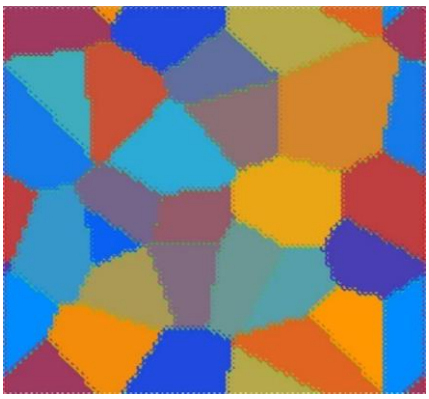

Figure 1: Polycrystalline graphene model with periodic boundary condition

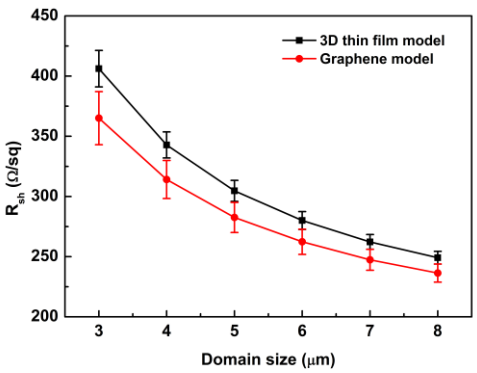

Figure 2: Variation of sheet resistance in 3D thin film model (black line) and graphene model (red line)