Bandgap scaling in bilayer graphene antidot lattices

René Petersen and Thomas Garm Pedersen

Department of physics and nanotechnology, Aalborg University, DK-9220 Aalborg East, Denmark
Center for nanostructured graphene (CNG), DK-9220 Aalborg East, Denmark

rp@nano.aau.dk

Abstract

A graphene antidot lattice (GAL) is a graphene sheet in which a periodic array of holes has been made. This opens up a bandgap which can be tuned by varying the size and the geometric configuration of the holes [1]. It has been shown previously [1, 2] that the bandgap of monolayer GALs scales linearly with the factor $A_{removed}^{1/2}/A_{total}$, where $A_{removed}$ is the area of the hole and A_{total} is the area of the unit cell before the hole is made, and that not all possible GALs possess a large bandgap. In our most recent work, we have investigated bandgap scaling in bilayer GALs on the basis of a tight binding model, by considering geometries as the one shown in Figure 1. We find that the bandgap in bilayer GALs follows a fundamentally different scaling law than the bandgap in monolayer GALs, as shown in Figure 2 below, and we have provided an explanation for this behaviour by using the Dirac model of graphene. Furthermore, we have investigated the effect of imposing an electric field perpendicular to the bilayer GAL structure. In pristine bilayer graphene, bandgap tunability between 0 eV and 0.25 eV have been obtained [3], but tunability outside this range has not been reported. We find that the bandgap tunability in bilayer GALs may be extended as compared to gap tunability in pristine bilayer graphene, as shown in Figure 3.

References

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[2] R. Petersen, T. G. Pedersen, and A.-P. Jauho, ACS Nano, **5** (2011) 523
[3] Y. Zhang, T.-T. Tang, C. Girit, Z. Hao, M. C. Martin, A. Zettl, M. F. Crommie, Y. R. Shen, and F. Wang, Nature, **459** (2009) 820.
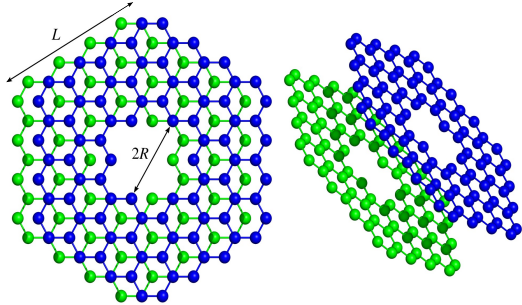
Figures

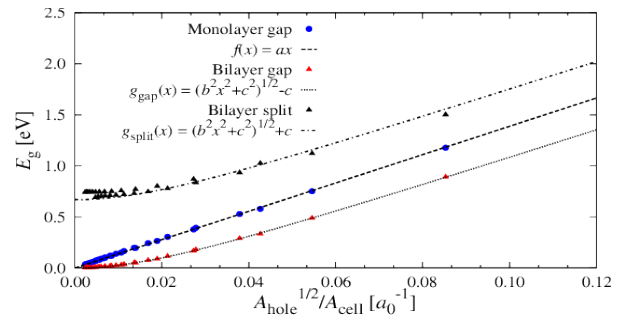Figure 1: Unit cell of a triagonal bilayer GAL.

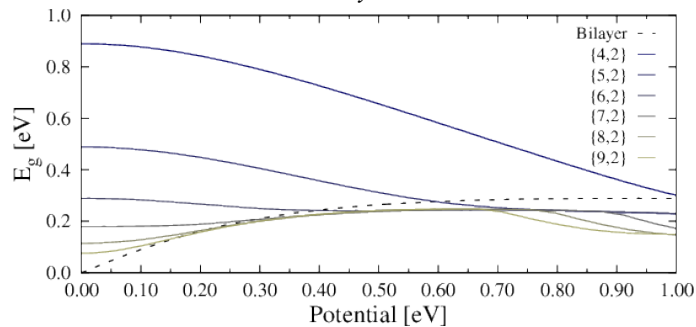Figure 2: Bandgaps of triangular GALs for the mono- and bilayer case.

Figure 3: Bandgap of a triagonal bilayer GAL under an applied bias.