# Nanoscale electronic manipulation of 2D molecular templates

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Weak interlayer coupling in 2-dimensional layered materials such as graphite gives rise to rich mechanical and electronic properties in particular in the case where the two atomic lattices at the interface are rotated with respect to one another. A lack of crystal symmetry leads to anti-correlations and cancellations of the $p_z$ orbital interactions across the twisted interface, which gives rise to low friction behavior and low interlayer electrical transport. Using our recent nano-fabrication and manipulation technology[1] we studied the interlayer electrical conductivity as a function of twist angle between two misoriented graphene layers with unprecedented angular resolution of ~ 0.1°. The angular dependence indicates that the electrical transport across the interface is dominated by a phonon assisted channel which conserve the momentum of conduction band electrons, tunnelling across the twisted Dirac bands. Most intriguingly, the conduction is significantly enhanced within a narrow angular range of less than 0.5° at pseudo-commensurate angles of 21.8° and 38.2°. This provides the first experimental evidence for the existence of a 2-dimensional interface state originating from the coherent coupling of electronic states in the twisted sheets due to commensurate superlattices[2]. In addition, we use numerical methods to study the shear forces of the twisted graphene flake sliding on a graphene substrate. We found that the sliding force is dominated by rim forces originating from incomplete Moiré tiles at the periphery. This mechanism is distinctively different from the so-called edge effect due to lattice relaxations and imperfections of the edge atoms. Moreover, the sliding force scales with area if a commensurate superstructure is formed at the twisted interface. An interesting case results for a twist angle of 30° at which a quasi-crystalline, fractal like, interface structure is formed leading to virtually vanishing sliding forces for the fundamental dodeconal tiling units independent of their size[3].

References

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