Evidence of ultraviolet transparency of graphene on $SrTiO_3$ induced by excitonic Fano anti-resonance

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Graphene manifests prominent signatures of many-body effects of electron-electron and electron-hole interactions. This is distinctly revealed in the optical conductivity as red-shift and asymmetry of the van Hove peak observed at ~4.6 eV. Interestingly, due to its two-dimensional nature, one may expect to tailor its many-body effects by substrate properties. Here we present a intriguing phenomenon of the electronic bands of substrate interacting strongly with graphene bands. Using spectroscopy ellipsometry, for graphene on $SrTiO_3$ we observe a drastic renormalization of the optical conductivity with almost full transparency in the ultraviolet region. Through phenomenological analysis this can be explained with Fano anti-resonance due to excitonic states residing between graphene conduction bands and new hybridized valence bands originating from carbon p_z-orbital of graphene and oxygen p_z-orbital of $SrTiO_3$. Ultrafast optical pump-optical probe measurements and density functional theory calculations further support existence of hybridization and also explain important features of the optical conductivity.

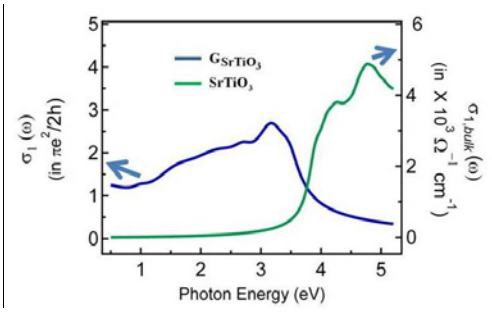

Fig.1. Real part of the optical conductivity ($\sigma_1(\omega)$) and Fano line-shape analysis.