Impact of Short Range Scattering in Graphene Electronics

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THE extremely high carrier mobility of graphene, in excess of 100,000 $cm^2V^{-1}s^{-1}$ [1], has inspired a large number of new opportunities for this amazing material. Some examples, include ultra-thin-body graphene transistors potentially enabling radio frequency (RF) circuits operating in the terahertz regime, graphene interconnects with low resistance and capacitance to replace copper, and a cost-effective replacement for Indium Tin Oxide (ITO) transparent conductive electrodes in light emitting diodes (LEDs), solar cells and flat panel displays [2-4].

In spite of these applications, the predominant interest in graphene research has focused primarily on studying the low carrier density (n_s) transport regime < 1-2x10^{12} cm^{-2}, where record mobility values have been achieved. However for almost all applications of graphene, typically operating carrier densities are greater than 2x10^{12} cm^{-2}, especially in applications of graphene operating as a transparent conductor or in radio frequency transistors where large sheet charges are necessary for adequate gain. While low carrier concentration transport studies have allowed for many fundamental studies of relativistic physics and ballistic transport in devices, transport studies at higher carrier densities are as important for many commercial applications. Therefore, this work focuses on examining the transport limiting mechanisms in graphene and their implications on three different device applications (1) transparent conductive electrodes, (2) graphene-metal contact resistance, and (3) graphene interconnects. Through Hall Measurements on graphene grown by chemical vapor deposition, we examine the high carrier density mobility degradation due to short range scatters. To isolate the physical origin of short range scattering in graphene, we have examined the mobility of various growth conditions comparing copper and nickel synthesized graphene. Furthermore, we compared the effect of various dopants, such as Aluminum oxide, on carrier mobility and extracted the ratio between the density of charged impurity and short range scatters from our data as well as values from literature [5][6].

References

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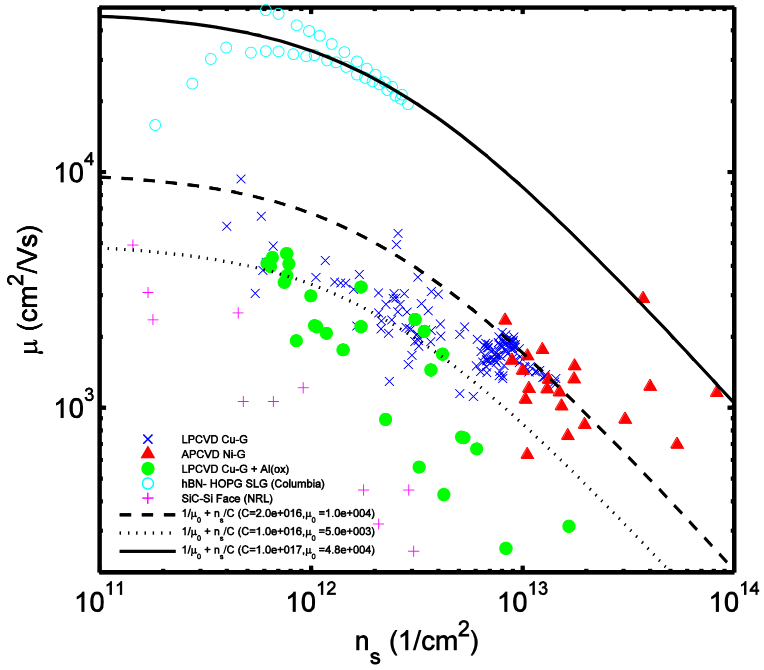
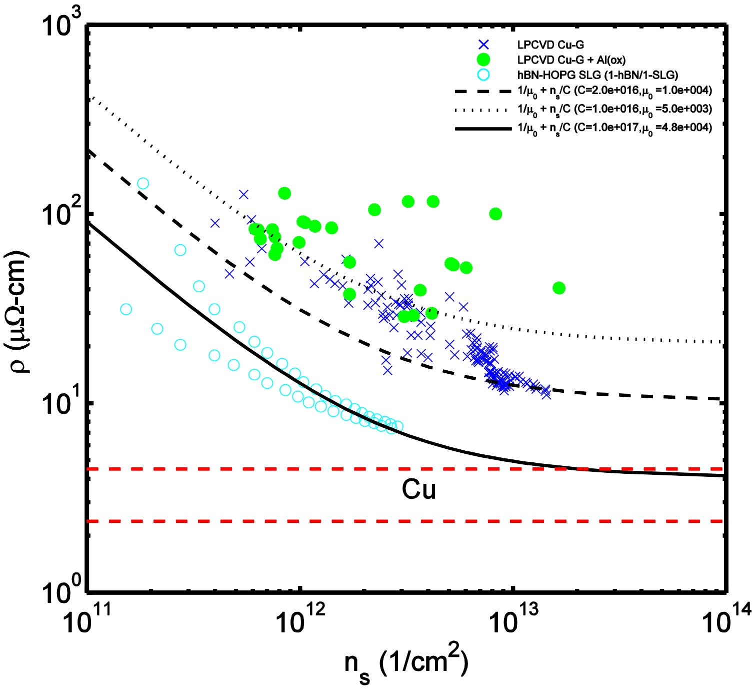
Figures



Mobility versus Carrier Concentration for various films. (x) – low pressure CVD graphene grown on Cu (Δ) – ambient pressure graphene grown on Nickel (●) LPCVD Graphene on Copper with Al(ox) layer (○) HOPG on hBN [5] (+) SiC Si Face [6]



Specific Resistivity plotted as a function of carrier concentration. Copper values were obtained from literature [2].