High Pressure Electrical Transport Evolution of Single Crystal Graphite

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Keywords: high pressure, electrical, graphite.

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Abstracts: The phase transition of graphite at 14 GPa and room temperature had been discovered more than a half century. Lots works had been performed on it and Previously, several structure models have been proposed to explain this phase, including hexagonal diamond [1, 2], M-carbon [3], Z-carbon [4], amorphous-carbon [5] and others [6]. But all of them can be fully explain the exmperimental observations. So, until now, lots of intrinsic details of this controversial carbon phase remain unresolved.

Graphite as a 2D Dirac semimetal has a characteristic anisotropy in electrical conductivity due to the distribution of the π electrons along the carbon layers. But the resistivity strongly dependens on the flatness of graphenen layers. The evolution of the π bonds during phase can be probed by measuring the electrical conductivity along different crystallographic directions. So the in-situ high pressure electrical transport evolution of single crystal graphite are measured in silicone oil along ab (ρ_{ab}) and c axis (ρ_c) in one sample respectively (Fig 1). As shown in Fig 1, unde high pressure the resistivity in different orientations display completely different pressure dependence. Before 14 GPa, ρ_c shows a linealy decrease following the pressure increase, but the ρ_{ab} has a clear positive pressure dependence. Above 14 GPa, during the phase transition the ρ_c only fluactuates in about one order, while the ρ_{ab} increases by about five orders of magnitude in total. The hugh different pressure dependence of electrical transport in different orientations indicate the high resistance of the high pressure carbon phase mainly induced by the increase of in-plane resistivity. It further suggests during the pressure driven phase transtion of graphite, the sp^2 to sp^3 evolution is a very sluggish process.

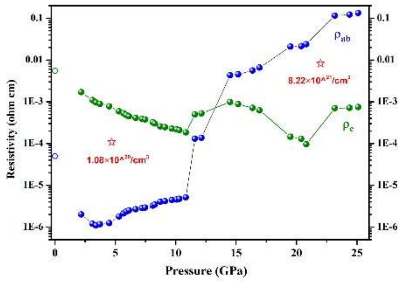

Figure 1. Room temperature resistivities versus pressure measured along the *ab* plane and *c* axis of single crystal graphite, respectively. The red open stars and numbers represent the charge carrier density at 4.7 and 22 GPa.

Acknowledgments: The research is supported by National Nature Science Foundation of China (U1530402).

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