

Mo catalyzed In-situ TEM synthesis of Graphene

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Graphene has been a topic of keen research interest since its isolation in 2004 [1]. Due to its properties like very high carrier mobility, thermal conductivity and mechanical strength, graphene is an ideal material for device fabrication. Recent development of chemical vapor deposition (CVD) has enabled large area synthesis of high quality graphene films with controllable thickness and crystal size. Cu and Ni are commonly used substrate for synthesis of high quality graphene. Among different metals, catalytic role of Mo during graphene formation is least studied. In this work, we study Joule heat induced graphene formation inside transmission electron microscope (TEM) with real time observation Mo-C interaction and change in electrical property during graphitization.

Mo included amorphous carbon nano-fiber (Mo-CNF) was used as starting material. Mo-CNF was fabricated using our previously reported method [2]. Bias voltage was applied to the tip of Mo-CNF. During application of voltage, joule heat comes in to play causing melting of embedded Mo and its voltage driven electromigration. During electromigration of Mo, amorphous CNF changes to graphitic form as shown in Figure 1(a-h). Figure 1(i-k) show that as synthesized graphene is crystalline with no presence of amorphous carbon. Simultaneous electrical measurement taken during transformation of CNF to graphene shows sudden increase in current during electromigration indicating graphene formation as shown in Figure 1(l). In summary, we demonstrated that Mo can act as an efficient catalyst for graphene synthesis and can be explored for large area graphene synthesis.

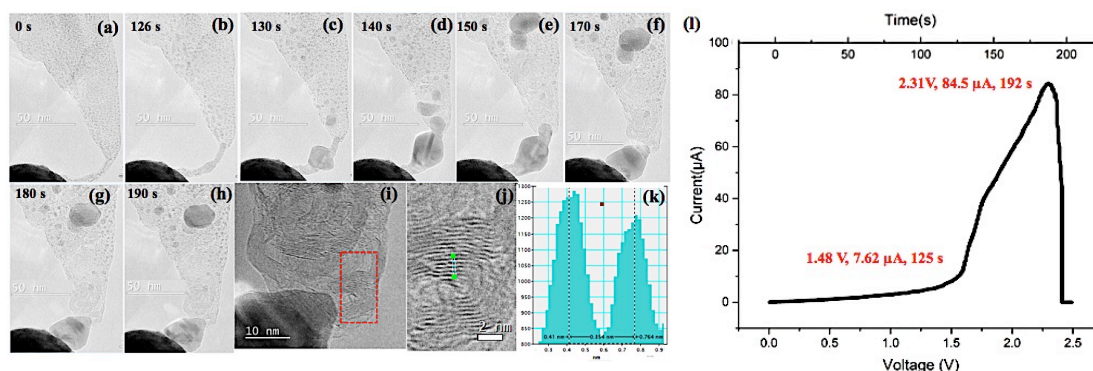


Figure 1. (a-k) Screenshots taken from in-situ TEM video showing transformation Mo-CNF to graphene under application of bias voltage at different time interval. (l) Corresponding IV curve showing change in electrical property of Mo-CNF during electromigration and graphitization of Mo-CNF.

References [1] Novoselov et al. "Electric field effect in atomically thin carbon films." Science 306, no. 5696 (2004): 666-669.

[2] Sharma et al. "In situ TEM synthesis of Y-junction carbon nanotube by electromigration induced soldering." Carbon 132 (2018): 165-171.