Graphene from simple molecules at room temperature: synthesis, processing and applications

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An innovative, simple, efficient and cheaper way to chemically synthesize graphene starting from simple molecules (as benzene or n-hexane) at ambient conditions (temperature, atmosphere and pressure) is reported. The largest graphene sheets chemically synthesized, with lateral size in micrometric dimensions (Figure 1, left), can be obtained through a chemical reaction occurring at the confined environment of an interface between two immiscible liquids [1,2]. Those special configuration allows the solid product be spontaneously deposited at the liquid/liquid (L/L) interface, resulting in transparent thin films that can be easily transferred and deposited over ordinary substrates. This methodology allows both the synthesis and thin film processing of graphene in one-pot and one single step. Based on several characterization techniques, a chemical mechanism to explain the conversion of benzene to graphene is proposed [1].

Due to the specific chemical reaction involved in the synthetic process, the final product is in fact a nanocomposite between large graphene sheets and iron oxide (Fe_2O_3/Fe_3O_4) nanoparticles. The oxide can be further chemically removed yielding pure graphene samples, or can be used for specific application. Two interesting application of those graphene/iron oxide nanocomposite thin films will be demonstrated, as 1) flexible supercapacitor [3] or 2) a precursor to electrochemically synthesize innovative graphene/Prussian blue nanocomposite [4], based on an adaptation of a carbon nanotubes-based nanocomposites route developed in our group [5]. The resulting material is transparent and its application as both electrochromic material and cathode for ion-based batteries will be presented [4].

Finally, the potentiality to extrapolate this route to a N-doped graphene (starting from pyridine) [1] or to a total chemical synthesis of graphene/polymer nanocomposites (Figure 1, right) will be demonstrated [6,7], as well as the application of the final film materials as active layer in photovoltaic devices [6] or flexible supercapacitor [7].

References

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Figures

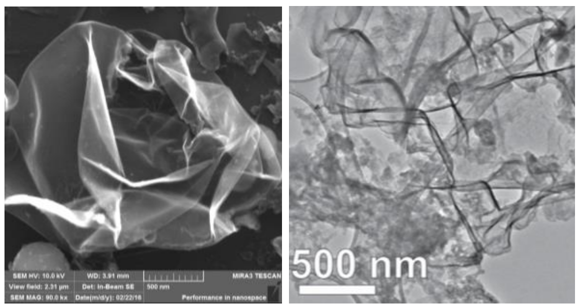

Figure 1: MEV images: a graphene sheet chemically synthesized (left); graphene/polythiophene nanocomposite chemically synthesized (right)