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A Novel Method to Form Carbon Nanocomposites

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Abstract: Carbon-coated nanocomposites have been synthesized by a self-heating detonation process using nitro-amine CHNO explosives prooviding the need of high temperatures, high shock waves, and parts of carbon sources in the presence of catalyst. The products of carbon nanomaterials are characterized by XRD, EDX and TEM techniques. In this work, various carbon nanostructures or metal nanocomposites can be efficiently obtained from the detonation of the desired molecular precursors. In summary, catalytic detonation of carbon-rich explosives can be designed as a simple method and with the potential application for the rapid production of nano-structured materials of graphitic carbon-encapsulated nanoparticles and 2D Graphene.

Introduction: Due to their unique properties, carbon nanocapsules (CNCs) are an extremely attractive raw material for functional as well as structural applications. as traditional synthesis like arc-discharge, CVD or laser ablation is energy- and setup-intensive, routes to cheap mass production are highly demanded [1-3], especially for their utilization in structural materials, where large amounts are required. The novel structure of encapsulating second phase inside carbon shells can immunize the encapsulated species against environmental degradation effects while retaining their intrinsic properties, and can also offer an opportunity to investigate dimensionally confined system. However, these processes are both high energy and hardware intensive, which lead to high cost of nanostructures and therefore constrains their practical application [4-6].

Experimental: Before the detonation experiments, the starting materials were mixed in desired ratios. When the detonation occurs, pressure and temperature were generated inside the vessel, varied with the loading density of RDX. After the detonation, the vessel was cooled in air to ambient temperature. High-resolution TEM images were performed operated at 200 kV, which is equipped with energy dispersive X-ray spectrometer (EDX) for elemental analysis.

Results and Discussion:
before the detonation experiments. The materials used in this study can be formulated, including explosive, carbon source, and catalyst, from which carbon nanocapsules can be effectively synthesized. Figure 1 is a typical result of the sample obtained from the detonations of mixture. Amorphous carbon background in the products contributes to the broad diffraction peak in proximate to the graphite peak. A typical TEM image of the resulted material showing that the structures with the carbon shells show relatively defective structure observed can be effectively protect the iron cores against the environmental degradation (Figure 2). As shown in Figure 3, it indicate that the mixture result in detonation reaction and produce graphene and nanostructures under the condition. The above data show that the detonation-induced is able to controllably produce well-constructed nanostructures. As can be seen in Figure 4, in the formation of the nanostructures of nanoencapsule with the nano-sized metal particles , the explosive detonative plays an important role with the heat and the carbon species produced from the detonation promote the decomposition and the reduction of catalyst particle and this lead to help the structure and mechanism control. It is interesting to note that these results experimentally used in this study show that it is possible for a cheaper process and can be as an alternatives compared to these high energy and hardware intensive processes to assemble nano-sized carbon nanomaterials under catalyzed-blast process.

Conclusion: This novel approach has the potential ability to convert waste energetic explosives to form highly valuable materials. This method represents a simple and low cost process towards carbon encapsulating structures, in which the needed high-temperature environment is self provided by the energy emitted from detonation. The results show that uniform carbon-encapsulated nanoparticle and graphene has been successfully synthesized through the detonation of designed mixture. Also, a further increase in carbon nanostructures yield and tailoring of structure defects may be available in relation to the optimization of reaction conditions.

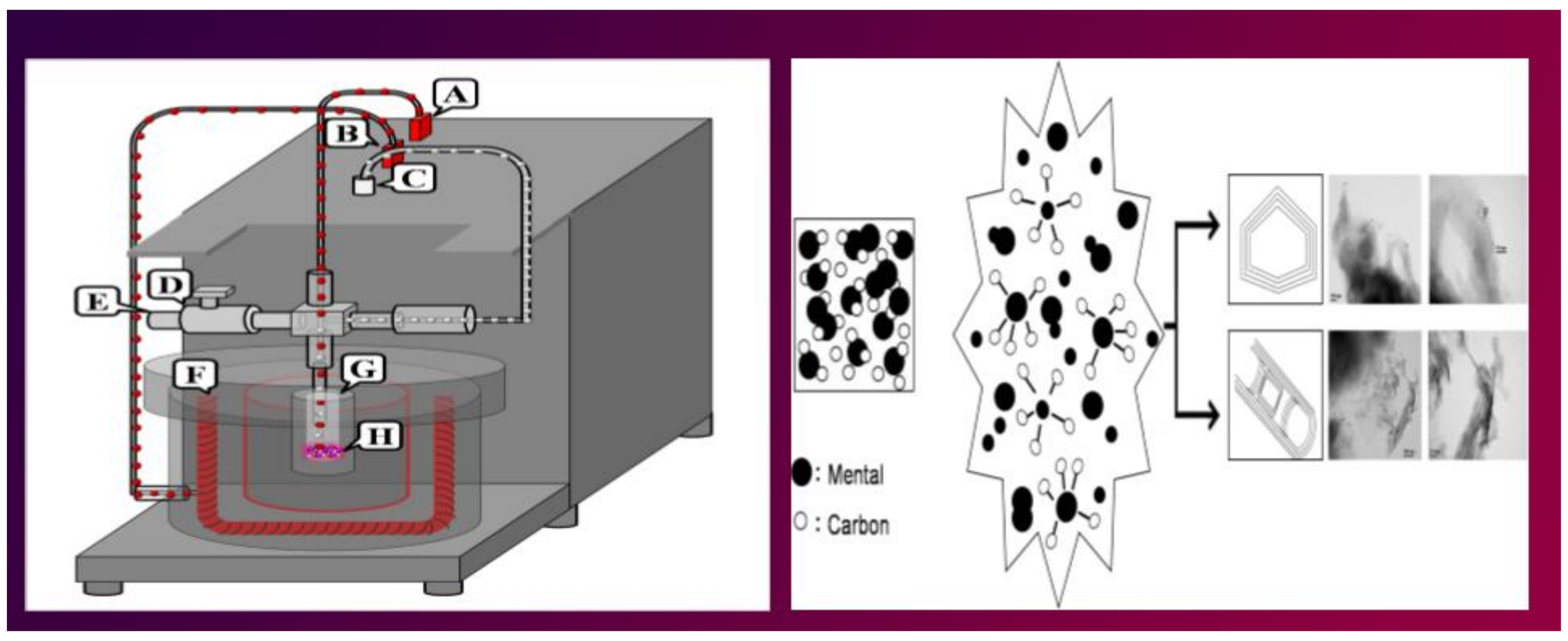

Figure 1. A schematic diagram of reaction system and proposed mechanism

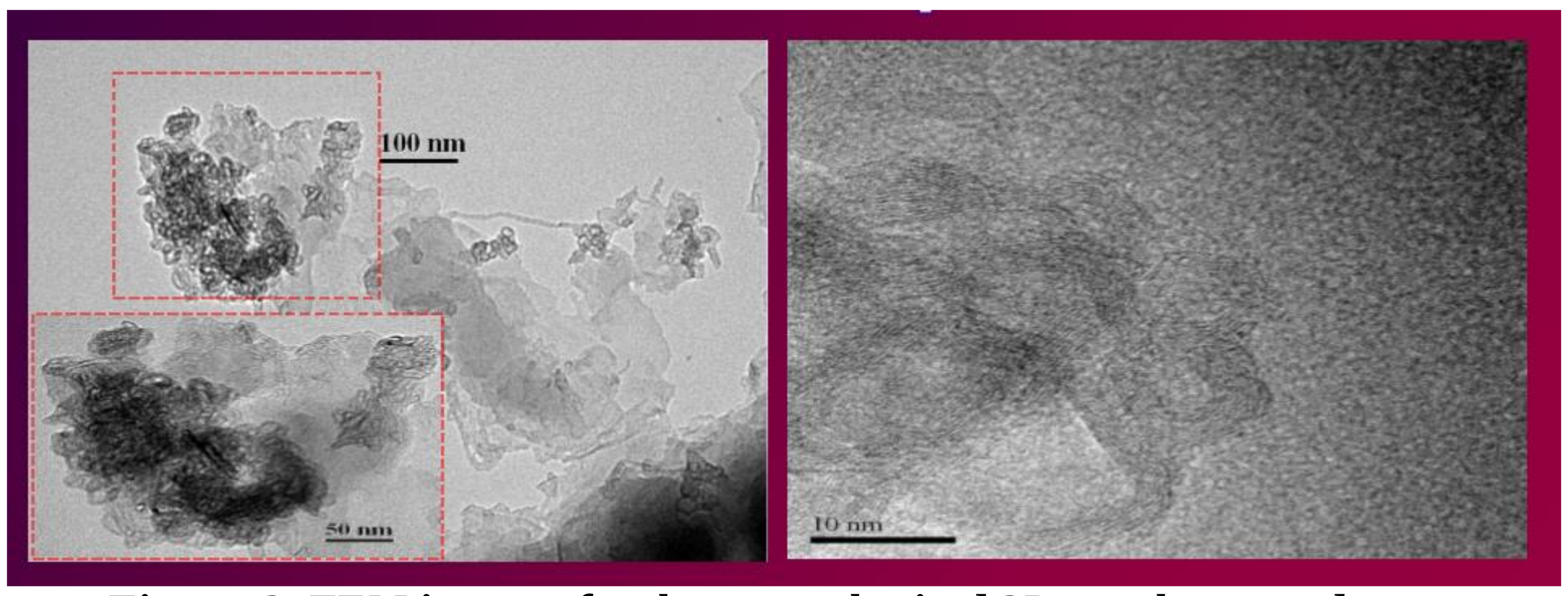

Figure 2. TEM images for the as-synthesized 2D graphene products.

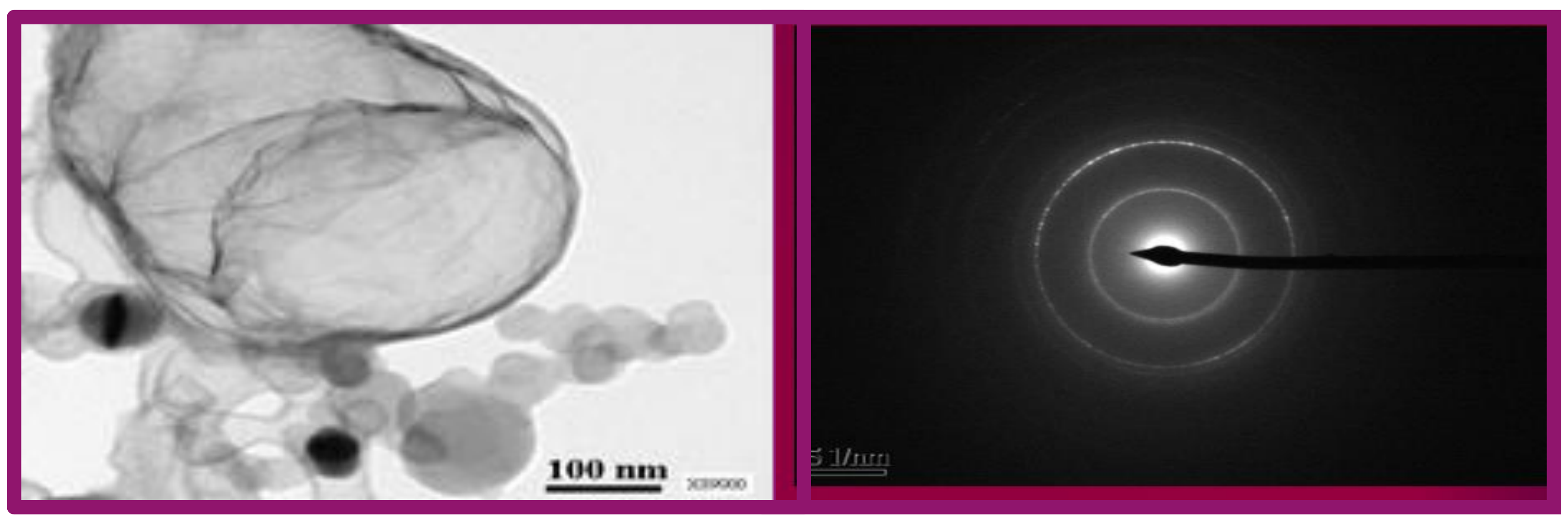

Figure 3. TEM and EDX spectrums of as-synthesized products

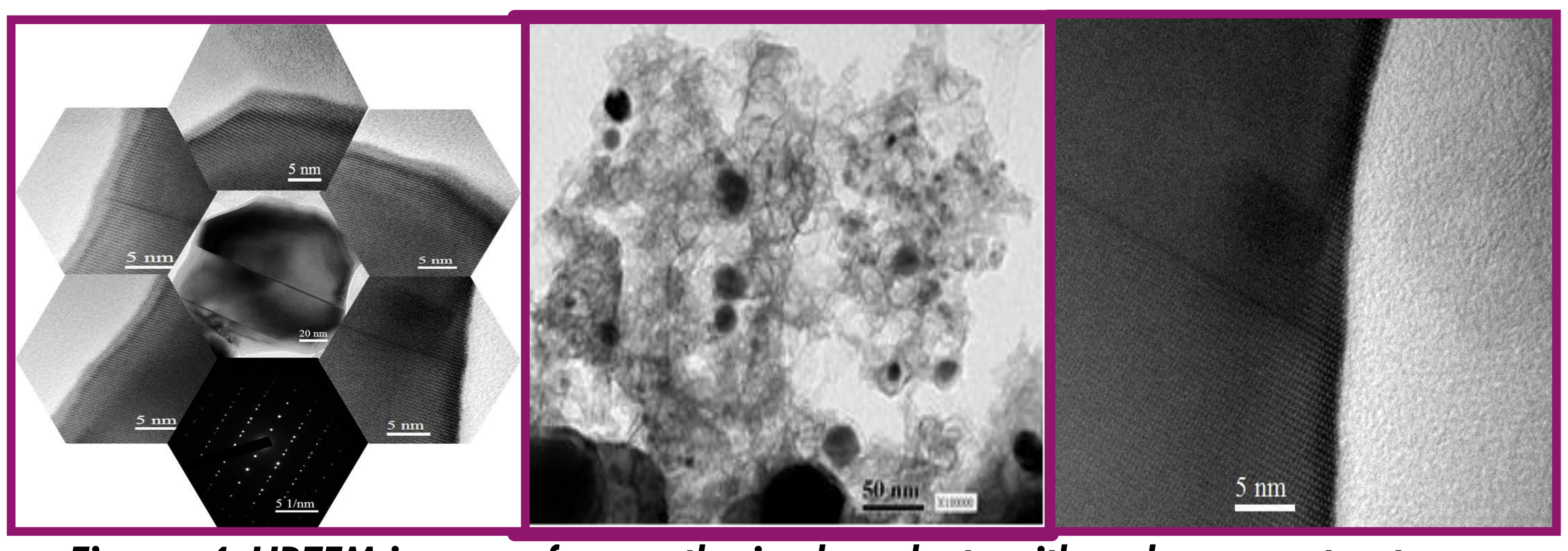

Figure 4. HRTEM images of as-synthesized products with carbon nanostructures

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