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Graphene – A Game Changer Material for Steel Industry

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Abstract

Following its isolation in 2004, graphene - a two dimensional single layer sheet of carbon atoms arranged in a honeycomb pattern, has generated a significant amount of interest in academia and industry alike [1, 2]. Various superlative properties of this wonder material have provided and continue to provide numerous opportunities for its application in several industrial sectors. These properties include high electron mobility, high electric current density, excellent heat conductivity, chemical inertness, impermeability to almost all molecules, high mechanical strength, high optical transparency, ease in conformal patterning and coating etc. Owing to its incredible properties, graphene based materials have potential to significantly improve product performance in several existing applications such as photovoltaics, transparent conductors, sensors, composite materials, membranes or gas barriers, conductive inks or paints and energy generation and storage devices [2]. It can provide opportunities for innovating game changing new products and act as a catalyst for new applications and markets. Moreover, the possibility to functionalize graphene is driving the continuous expansion of ensemble of graphene and/or graphene based hybrid materials towards enhancing the performance of various advanced material systems or technological solutions.

The market of graphene applications is essentially driven by progress in the production of graphene with properties appropriate for the specific application [2]. There are essentially two approaches to synthesize graphene through either top-down or bottom-up approach, which are being used and developed to prepare graphene of various dimensions, morphology and purity. Top-down approach involves methods such as mechanical exfoliation, chemical exfoliation and chemical exfoliation via graphene oxide, whereas bottom-up approach includes synthesis methods such as chemical vapor deposition (CVD), epitaxial growth on SiC and synthetic chemistry based molecular assembly approach. The properties of synthesized graphene are dictated by the method used for its synthesis, which directly determines its application for corresponding products as both of them heavily depend on each other. For example, graphene synthesized using chemical exfoliation approach might consist surface defects, which lowers the quality of the produced graphene flakes and hence limit its application to products such as coatings, paint/ink, composites, energy storage. On the other hand, graphene produced via bottom-up approach methods could be consisting less defects and hence provide an opportunity for its application to high-end products in photonics, nanoelectronics, transparent conductive layers, sensors, and bioapplications. Among several properties mentioned previously, properties such as high degree of electrical conductivity together with promising anti-corrosion properties of graphene can provide technological solutions to the customers of steel industry and fulfill their demand of constantly developing novel and more sophisticated products. Coating plays a crucial role in improving surface quality and providing protection for a substrate [3]. Graphene based advanced functional coatings can prove to be a game changer material for steel industry and its customers. The possibility to produce large quantities of high quality graphene and innovating different methods to deposit functional coatings based on graphene materials on steel substrates is driving the research and development of innovative technology in steel industry for various application. For example, graphene-coated steels could boost the energy efficiency of solar panels, or make buildings longer lasting by reducing damage caused by water or corrosive environment.

The talk will illustrate and review various promising applications of graphene-based materials with respect to steel industry. The future perspectives of graphene based coatings will be discussed.

References

1. K. S. Novoselov, A. K. Geim, S. V. Morozov, D. Jiang, Y. Zhang, S. V. Dubonos, I. V. Grigorieva, and A. A. Firsov, Science 306, 666 (2004).
2. K. S. Novoselov, V. I. Fal'ko, L. Colombo, P. R. Gellert, M. G. Schwab and K. Kim, Nature 490, 192 (2012). Y. Tong, S. Böhm and M. Song, Austin J Nanomed Nanotechnol. 16, 1 (2014).

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