

# **A Progress Report on Graphene Industry: “What You Can Do for Graphene”**

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The pressing needs of graphene industry for truly cost-effective graphene production processes and the so-called “killer applications” of graphene will be highlighted in this report. Despite the hype about the tremendous application potential of graphene, no company in worldwide graphene industry has yet generated any significant revenues/profits out of sales of graphene materials or graphene-enhanced products. Truly breakthrough graphene production and application technologies are essential to the emergence of an economically viable graphene industry.

This presentation will provide a critical review on several popular processes for producing isolated graphene sheets. Emphasis will be placed on the processes that are more suitable for mass production of graphene. The advantages and shortcomings of these processes will be highlighted. This will be followed by a brief discussion on some of the potential applications of graphene. The research and development needs of graphene industry will be summarized.

Specifically, Dr. Jang will offer some personal perspectives on the rapidly emerging graphene industry, emphasizing the opportunities and challenges in commercializing graphene materials and products. The technical and commercial challenges experienced by graphene producers will be high-lighted. For instance, a significant challenge is the notion that graphene is a unique material that requires different processes to bring out the most desirable characteristics for a particular application. In other words, different processes are required to produce different types of graphene materials for different applications in different market sectors.

There are also technical, economical, and regulatory issues that must be addressed in order for the large-scale production of affordable graphene materials to be fully realized. This will be followed by a discussion of some of the potential and realized applications of graphene materials, including supercapacitors, batteries, and functional composites.

The speaker, Dr. Bor Z Jang, is uniquely qualified to present this topic for the following reasons: Dr. Jang filed his first patent application on graphene as early as October 2002 [1]. Before Drs. Novoselov and Geim published their historically significant paper in October 2004 [5], Dr. Jang’s research team had already delivered one technical paper [2] and filed for three patent applications [1,3,4] on graphene.

Further, the research team led by Dr. Jang and Dr. A. Zhamu developed several of industry’s most widely used graphene production processes/methods, including the chemical oxidation and intercalation method for mass production of single-layer graphene in 2002 & 2004 [1,3], the liquid-phase exfoliation method in 2007 [6], the supercritical fluid process in 2006 [7], the electrochemical exfoliation method in 2007 [8], etc. Dr. Jang and his business partner, Dr. A. Zhamu, co-founded Angstrom Materials, Inc. (AMI) in 2007. Angstrom is currently world’s largest producer of single-layer graphene oxide and reduced graphene oxide suspension and powder.

The Jang/Zhamu team was also the world’s very first to invent/develop several graphene-enhanced products, such as graphene composites in 2002 [1], graphene for fuel cells in 2004 [4], graphene-based supercapacitors in 2006 [9], graphene-enhanced lithium battery electrode materials (e.g. graphene/Si anode in 2007) [10], graphene thermal film in 2007 [11], graphene ink in 2008

[12], graphene-enhanced grease and lubricant [13], graphene-modified tires [14], etc., just to name a few.

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