

TECHBRIEF

A COST-EFFECTIVE PROCESS FOR MAKING GRAPHENE FROM DOMESTIC COAL FOR USE IN COMMERCIAL PRODUCTS

OPPORTUNITY:

The invention is a new cost-effective way to make high-quality graphene from domestic coal feedstocks. This graphene can be used to make a wide range of consumer products such as structural composites, water purification sorbents, stain- and water-resistant textiles, battery materials, and specialty pigments for paints and coatings. Graphene is an outstanding material made from honeycomb sheets of carbon just one atom thick. Graphene is one of the lightest, strongest, and thinnest materials ever discovered. It has a high surface area, high thermal conductivity, strong chemical durability and high electron mobility making it ideal for use in products requiring mechanical strength, corrosion resistance and thermal/electrical conductivity. This inventive new process also co-produces rare earth elements (REEs) and distilled crude oil liquid, which have their own markets. The co-production of three high value products makes this invention an opportunity to maximize the profitability of a coal-based manufacturing process.

CHALLENGE:

Despite their amazing properties, carbon nanomaterials have not been widely commercialized primarily because of their high costs and limited supplies. Currently, graphene costs approximately \$20,000,000 per metric ton and global production capacity is less than 2000 tons/year. The high cost and low supply of graphene are major factors limiting its use in new and innovative consumer products. These issues are driven, in part, by the expensive carbon feedstocks and complicated manufacturing processes currently used to make graphene. The invention overcomes these challenges by utilizing inexpensive & plentiful domestic coal in a simple one-reactor process. This approach brings the total manufacturing costs in line with other specialty materials, such as carbon fiber and carbon black, making the use of graphene in consumer products commercially viable.

OVERVIEW:

NETL researchers have discovered a method for making graphene directly from domestic coal with the co-production of rare earth elements and distilled crude oil liquid. This process has been demonstrated with sub-bituminous, bituminous, and anthracite ranks of coal. Coal naturally contains aromatic and graphite-like carbon structures making it an ideal feedstock for making graphene-type nanomaterials. By using the natural building-block molecules contained in coal, the costs and technical challenges associated with making graphene are significantly reduced. The invention also co-produces rare earth elements and distilled crude oil liquid which have their own markets and value.

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ADVANTAGES:

The major advantage of this technology is it opens commercially sustainable pathways for the cost-effective production of graphene. The co-production of rare earth elements and distilled crude oil liquids offers opportunities for additional revenue streams in existing markets.

APPLICATIONS:

The development and commercialization of cost-effective methods for large-scale production of graphene would be transformational for carbon nanomaterial technologies. Currently, NETL is exploring the following applications for coal-derived graphene:

- Additive to improve mechanical properties and durability of cement and concrete
- Battery and electrode materials
- Water purification sorbents
- Bactericidal/viricidal coatings for hospital applications
- 3D printing composites and materials
- Water- and stain- resistant textiles
- Catalyst materials and supports

Low cost graphene, manufactured from coal, is a critical enabling technology for these and other emerging applications.

RELATED PATENTS:

U.S. Patent Pending (non-provisional patent application)

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Title: Production of Graphene-structured Products from Coal Using Thermal Molten Salt Process

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