

Scientists suggest using a cryptozoic mineral to create new lightweight carbon composites

August 31 2022



The obtained material sample. Credit: Sergey Gnuskov/NUST MISIS

Scientists at MISIS University and Skoltech have developed a technology for the production of a new composite material based on shungite and carbon fibers in a graphite matrix. Due to the combination of low

density, high strength and chemical stability at elevated temperatures, it can be used to produce fuel cells, super-capacitors, and next-generation aircraft engine components. The work was published in *Polymers*.

Composites with carbon fillers are widely used in modern industry. They can be used for the production of units and equipment operating in [extreme conditions](#), due to their unique properties—high chemical and temperature resistance. Unlike heavy refractory metals that are readily oxidized at elevated temperatures, [carbon materials](#) have exceptional high temperature resistance and low weight. At the same time, properties of different carbon materials vary a lot—from diamond to graphite.

Materials scientists are now developing a new class of composites consisting of various carbon reinforcing fillers in a graphite matrix obtained by carbonization, i.e., transformation of a polymer into a carbon material.

Scientists from MISIS University and Skoltech have presented the technology of fast and economical production of such a composite and identified the optimal parameters for [heat treatment](#) to achieve the best performance in terms of "crack resistance"—that is, resistance to the initiation and propagation of cracks that largely determines the strength for brittle and quasi-fragile materials.



Alexey Salimon, Ph.D, co-author and Head of the Department of Physical Chemistry. Credit: Sergey Gnuskov, NUST MISIS

The composite synthesis process is similar to "baking" a "dough" made from an elastomer (a soft rubber-type polymer) reinforced with a "filling" at several temperatures above 180°C. The short carbon fiber often used as a "filling" is however quite expensive and its available volume is limited. Therefore, in the new material the short [carbon fibers](#) were partially import-substituted with shungite. Shungite is a unique Precambrian rock consisting of almost 100% carbon that was first discovered in Russia.

The result of processing is the enrichment of the initial product with carbon accompanied by simultaneous restructuring. The easily shaped

polymer is thereby turned into one of the most stable carbon compounds, such as graphite or diamond. Given the unique rigidity of these materials it is almost impossible to machine necessary part shapes from graphite or diamond.

"The purpose of this study was to optimize the carbonization process to increase the crack resistance depending on the processing temperature and the initial mixture composition, namely, the volume fraction of the reinforcing phases. A careful selection of conditions was undertaken to obtain the highest values of the critical stress intensity factor in samples carbonized at the temperature of 280 degrees Celsius," says Alexey Salimon, Ph.D, co-author and Head of the Department of Physical Chemistry.

The researchers expect the obtained materials to find use for the manufacture of key parts of fuel cells (devices for direct conversion of the fuel [chemical energy](#) into [electrical energy](#) without combustion), components of chemically resistant equipment, complex pumping equipment for oil production at record depths and in the harshest conditions (sand, hydrogen sulfide, temperature over 200 degrees Celsius). Another promising area for the use of new materials will be to create a new generation of aircraft engine components.

More information: Semen D. Ignatyev et al, Fracture Toughness of Moldable Low-Temperature Carbonized Elastomer-Based Composites Filled with Shungite and Short Carbon Fibers, *Polymers* (2022). [DOI: 10.3390/polym14091793](https://doi.org/10.3390/polym14091793)

Provided by The National University of Science and Technology MISIS

Citation: Scientists suggest using a cryptozoic mineral to create new lightweight carbon

composites (2022, August 31) retrieved 15 May 2024 from
<https://phys.org/news/2022-08-scientists-cryptozoic-mineral-lightweight-carbon.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.