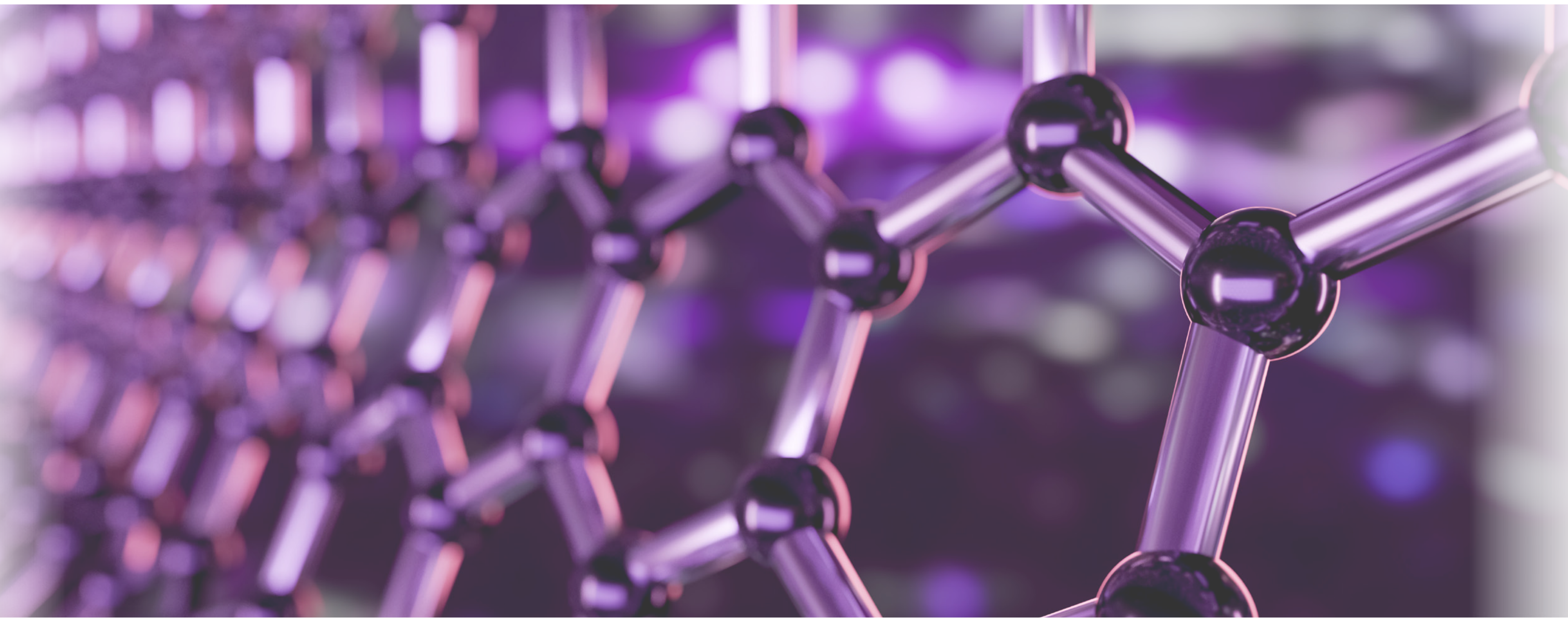
MASARYK UNIVERSITY

Plasma-Reduced Graphene Oxide Materials

The presented technology uses low-temperature atmospheric pressure electric plasma to start the fast plasma-initiated reduction-exfoliation of materials based on graphene oxide to so-called reduced graphene oxide (rGO), with properties partially similar to pristine graphene.

The technology is based on the use of an innovative and industrially proven source of low-temperature electric plasma, the so-called Diffuse Coplanar Surface Barrier Discharge (DCSBD).
This technology uses specially prepared graphene oxide, which is subsequently exposed to the effect of low-temperature atmospheric plasma. A special form of GO and an optimized plasma source using the thermodynamic properties of the reduction reaction of GO to rGO allow us to prepare plasma-reduced GO extremely quickly (~1s) and efficiently. The results demonstrate an improvement in the electrical properties of rGO by 6 orders of magnitude.



Seeking

Development partner
Commercial partner
Licensing
University spin out
Investment

IP Status

Patent application submitted (EP, PCT)

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CHALLENGE

Current processes to produce graphene, and materials derived from graphene, are very complicated and imperfect, which greatly limits its industrial use. An alternative to the direct production of graphene is the reduction of graphene oxide (GO), which can be produced relatively cheaply and easily. Reduction methods are most often based on thermal reduction of GO at high temperatures in an inert atmosphere, or reduction using toxic chemicals. By their very nature, both methods have many limitations (risk of fire, leakage of chemical substances, complicated production process), but most importantly, production is time-consuming and energy intensive. The goal of our efforts was to develop a GO reduction-exfoliation method that would solve all the mentioned limitations and enable the economically profitable application of graphene materials in a wide range of industrial sectors.

BENEFITS

- The technology works at atmospheric pressure, uses technical grade nitrogen as the working gas, and starts at laboratory temperature. The maximum temperatures reached during plasma-initiated reduction–exfoliation reach approx. 250 °C (and that only in the order of tenths of a second)
- The technology is based on the use of DCSBD plasma technology. It is a commercially available, proven, and industry-tested technology
- The entire technology is very robust in the sense of the absence of any extremely sensitive and expensive components and complicated instrumentation
- Plasma reduction-exfoliation of GO is a very fast process lasting a few seconds at most. In comparison, classical thermal and chemical reduction of GO is a lengthy process lasting hours to tens of hours
- The use of a non-isothermal plasma process provides the possibility of a simple modification of rGO during the process itself and thus the production of materials with specific properties.
- To the above advantages, it is a very energy-efficient production with low energy consumption and the absence of extremely expensive and complicated technologies reduces initial investments and lowers operating costs

APPLICATIONS

Commercial use finds graphene materials in additive manufacturing, that are possible to implement graphene of different compositions, forms, and properties into already used production processes to improve the mechanical, electrical, thermal, or catalytic properties of already available products. We are currently working on optimization of the production of plasma-reduced graphene oxide paper to verify it as electrodes in CR2032 flat button batteries.

Another potential use of thin paper from reduced graphene oxide is to improve the mechanical properties of composite materials such as laminated composites. Another example of the use of reduced graphene oxide in the form of paper with the addition of selected elements from the periodic table is its use as a catalyst for the chemical industry, especially the production of ammonia using the Haber-Bosch method or the production of methane from carbon dioxide using the Sabatier reaction. At the same time, our technology makes it possible to prepare plasma-reduced graphene oxide in the form of powder or highly porous aerogel, which can be applied in many other branches of industry.