Ultrasonically Assisted Preparation Of Graphene

Kathrin Hielscher

Hielscher Ultrasonics GmbH, Oderstr. 53, Teltow, Germany
kathrin@hielscher.com

Abstract

Since the extraordinary characteristics of graphite and graphene are known, several methods for its preparation have been developed. Beside to chemical production of graphenes from graphene oxide in multi-step processes, for which very strong oxidizing and reducing agents are needed. Additionally, the graphene prepared under these harsh chemical conditions often contain a large amount of defects even after reduction compared to graphenes obtained from other methods. However, ultrasound is a proven alternative to produce high quality graphene, also in large quantities.

The principle of power ultrasound applications is based on the coupling of intense ultrasonic waves into a liquid medium or slurry so that cavitation occurs. The cavitation-induced effects create a unique interaction between energy and matter, with hot spots inside the bubbles of ~5000 K, pressures of ~1000 bar, heating and cooling rates of >1010Ks^{-1}; these extraordinary conditions permit access to a range of chemical reaction space normally not accessible, which allows for the synthesis of a wide variety of unusual nanostructured materials. [2]

Researchers have developed different ways using ultrasound, but in general the graphene production is a simple one-step process.

To give an example of a specific graphene production route: Graphite is added in a mixture of dilute organic acid, alcohol, and water, and then the mixture is exposed to ultrasonic irradiation. The acid works as a "molecular wedge" which separates sheets of graphene from the parent graphite. By this simple process, a large quantity of undamaged, high-quality graphene dispersed in water is created. [1]

Other important ultrasonically assisted procedures of graphene treatment include the direct exfoliation of graphene, the preparation and functionalization of graphene sheets, the preparation of graphene oxide, nanoribbons, and carbon nanoscrolls as well as the nano-scaled dispersion.

References

[1] An, X.; Simmons, T.; Shah, R.; Wolfe, C.; Lewis, K. M.; Washington, M.; Nayak, S. K.; Talapatra, S.; Kar, S. Nano Letters **10** (2010) 4295-4301.

[2] Bang, J. H.; Suslick, K.S. Advanced Materials **22** (2010) 1039-1059.