Characterization of commercial graphene powders

Felix Lundkvist, Degree Project in Materials Science for Engineers Lund University, 2017-04-09 In collaboration with RISE Research Institutes of Sweden and BillerudKorsnäs AB

Out of 17 commercially available graphene powders only 2 or 3 seemed to contain actual graphene, according to characterization carried out in this project. These results reveal a market where customer cannot trust manufacturer, and where there is a great need for standardization and common nomenclature.

Graphene was introduced to the world in 2004 as a "super material" with great electrical, mechanical and thermal properties. Since then, scientists all over the globe have been competing in trying to find the best applications, and the best manufacturing methods for this new, exciting material. Graphene is a "2D" material, and consists of a very thin layer of carbon. Ideally the layer is a single sheet of atoms organized in a honeycomb lattice, but by convention up to 10 atom layers still count as graphene. With the popularity of this material, many graphene powder manufacturers have started to pop up all over the world. The fast expansion of the graphene market combined with the lack of adequate quality control, standardized characterization methods and a common terminology when classifying the powders, have caused severe concerns about the quality of the graphene powders for sale. Do these mass-produced powders contain real graphene, or just ordinary graphite? Graphite is a cheap material used in everyday objects such as pencils. Based on these concerns, 17 different commercial graphene powders have been characterized for this report. The powders have been characterized from a barrier application point-of-view, since graphene also has incredible barrier properties. This makes graphene a perfect material to integrate in food packaging barriers, where one wants to keep out e.g. oxygen and water vapour to prevent food spoilage. In today's food packaging barriers, aluminum foils in between plastic sheets are used to create gas barriers. This mixing of materials causes problems with recycling, a problem which could be solved by replacing the aluminum with graphene.

Surprisingly, only 2-3 out of the 17 powders seemed to contain actual graphene, which could be used in a real barrier application. The rest of the powders contained either flakes that were too thick and stiff to be called real graphene, behaving instead like graphite, or particles which had a structure resembling that of carbon black, a very cheap material used in e.g. car tires. Material that claims to be graphene is, on the other hand extremely expensive: hundreds of euros for only a few grams. With prices like this it is of great importance that the customer gets what they actually pay for, which is real graphene. In order to sort out the quality issues that the graphene market is experiencing right now, standardized characterization methods and a common nomenclature must be agreed upon by scientists, manufacturers and customers. Based on the results of this report the author would advise people not to buy mass-produced commercially available "graphene" until these problems are sorted out.