# A CHEMIST METHOD FOR MAKING PURE CLEAN GRAPHENE

S. Malik[a*], A. Vijayaraghavan[a,b], R. Erni[c], K. Ariga[d], I. Khalakhan[d], and J.P. Hill[d]

[a] Institute of Nanotechnology, Karlsruhe Institute of Technology (KIT)
D-76344 Karlsruhe, Germany
[b] University of Manchester, School of Computer Science
Manchester, M13 9PL, United Kingdom
[c]Electron Microscopy Centre, Swiss Federal Laboratories for Materials Testing and Research (EMPA)
Dübendorf, Switzerland
[d]WPI-Centre for Materials Nanoarchitectonics, National Institute for Materials Science (NIMS)
Namiki 1-1,Tsukuba, Ibaraki, 305-0044, Japan
[a*] Corresponding author: sharali.malik@kit.edu

Graphene is a two dimensional highly crystalline material and can be described as a single layer of all-sp$^2$ carbon atoms packed into a benzenoid ring structure [1]. It is widely used to describe the structural and electronic properties of many carbon-based materials, including graphite, fullerenes and nanotubes. For example, carbon nanotubes are usually thought of as graphene sheets rolled up into nanometre-sized cylinders. In 1859, Brodie discovered that pure graphite, when treated with potassium chlorate and nitric acid, formed crystalline graphitic acid (also known as graphitic oxide or graphene oxide). It is likely that he also made small amounts of graphene and in any case he speculated a new form of carbon was present and proposed the name Graphon (Gr)[2]. However, graphene was not shown to be stable until 2004 when Geim and Novoselov [3] described the ÒScotch tapeÓ method to peel graphene from samples of crystalline graphite. This mechanical exfoliation method is slow and labour-intensive as an optical microscope is required to hunt for single and few-layer graphene (FLG) amongst the material peeled-off.

Currently, the interest of physicists in graphene is enormous, but the interest of chemists has so far not been as great, probably resulting from the absence of well-established large scale methods to produce graphene. Therefore, the most important role chemists can play is the establishment of an inexpensive and simple wet-chemical method for making graphene. For example, intercalation compounds of graphite have been of interest for many years [4]. More than 100 reagents can be intercalated into graphite. They can be classified as either forming donor or acceptor compounds. Strong Br¿nsted acids such as $H_2SO_4$ and $HNO_3$ form acceptor compounds which generally remain in the molecular form in the intercalation process [5]. Our new intercalation method uses this technique and was the basis of an earlier procedure to make expanded graphite [6]. Our method leads to the production of graphene [7]. The graphene material was characterized by HRTEM (Figure 1), AFM (Figure 2) and Raman (Figure 3).

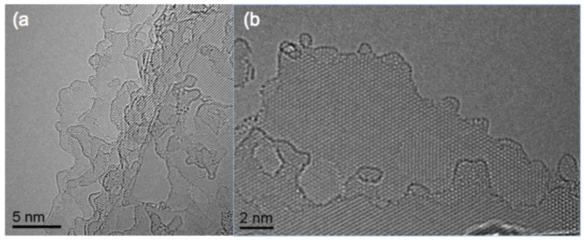


Figure 1: Atomic resolution, aberration-corrected TEM detail of graphene flakes (a) HRTEM micrograph of few-layer high purity graphene prepared by a chemical intercalation method. (b) HRTEM detail revealing the presence of clean, single, and bi-layer graphene areas.

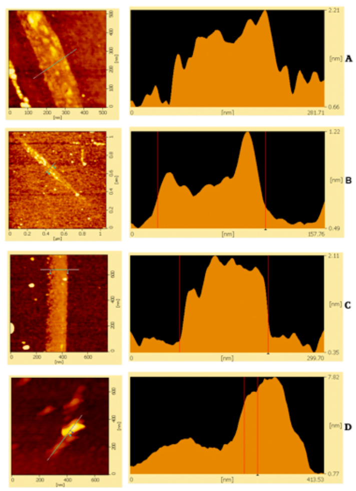


Figure 2: AFM of monolayer graphene flakes (A-C) and of a FLG flake (D).

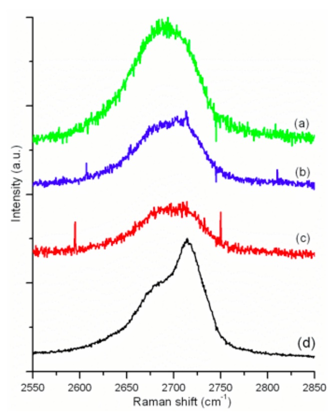


Figure 3: The G$'$ spectra of (a) monolayer graphene flake, (b) bi-layer graphene flake, (c) FLG graphene flake and (d) HOPG.

## References

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