

## Efficient graphene preparation by combined intercalation – exfoliation steps

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Despite the impressive improvements in the quality of large CVD- synthesized graphene sheets, the highest quality graphene layers are still obtained by mechanical exfoliation of pristine graphitic crystals. However, the method is notoriously tedious and gives a low yield. Worse still, large graphene flakes are often damaged by the exfoliation process itself. In this poster, we wish to address these limitations and present a novel approach to prepare large graphene flakes with increased yield. To this end we combine the standard mechanical exfoliation with chemical pretreatment of the graphite crystals.

In a first step, millimeter sized graphite crystals are treated with oleum (concentrated  $H_2SO_4$  with free  $SO_3$ ). These compounds, in particular the free  $SO_3$  intercalate into the graphite layers. Furthermore, due to the acidic nature of the solution, interlayer bonds at the rims of the atomic sheets might be broken-up. Subsequent reaction with alcohols expands the interlayer distance and loosens the van der Waals bonds further. In additional reaction steps, further intercalators may be utilized. In the final step, the standard scotch tape method is applied to the expanded graphite crystals and the resulting flakes are immobilized on glass or on Si/PMMA layers, Fig.1. Potential graphene flakes on glass are identified with a reflection microscope using the droplet condensation technique [1], refractive index matching [2], or on Si:dielectric composite layers by interference enhancement. The final test of whether a given flake is actually a single layer graphene is done by Raman microscopy. The absence of significant amounts of oxidized graphene or other reaction products is also confirmed in this way.

## References

[1] Hugo Gonçalves, Michael Belsley, Cacilda Moura, Tobias Stauber and Peter Schellenberg Appl. Phys. Lett., **97** (2010) 231905.

[2] Hugo Gonçalves, Peter Schellenberg Michael Belsley, Luís Alves, Cacilda Moura and Tobias Stauber, Proc. SPIE, **8001**, no 8001-133

## Figure

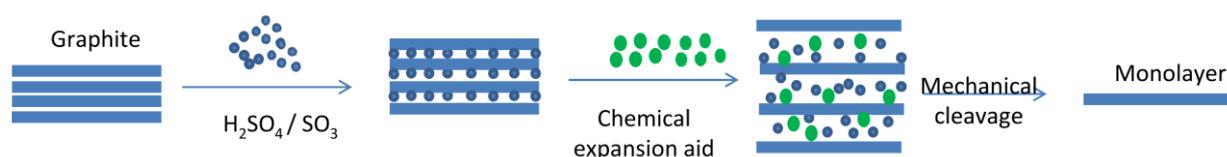


Figure 1: Schematic presentation of the treatment procedure. First,  $H_2SO_4 / SO_3$  is intercalated into the graphite layers. Reaction with alcohol and posterior application of additional intercalation compounds expand the layers further. Eventually, scotch tape exfoliation is used to separate the layers.