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Scalable production of processable graphene via electrochemical exfoliation

The worldwide hunger for efficient and clean energy storage and conversion technologies has become a great challenge due to increasing high-energy demands, environmental issues and depletion of fossil resources. The rapid rising of 2D materials over the past decade evidences not only a basic scientific interest but also their potential technological impact, as they might play a ground-breaking role in future electronics and the storage and utilization of clean electric power obtained from renewable resources.

Next to high-tech applications, commercialization is envisioned in composites, as already small amounts of additives in the range of 0.01-2% have substantial influence and can lead to exponential improvements in thermal, electrical and mechanical properties of the host materials.

For graphene, there has been a gap between laboratory-scale research and commercial applications for a long time due to the lack of reproducible bulk production methods at low cost level. Today many of these challenges seem solved, with production capacities reaching ton scale for both graphene and graphene oxide materials and the first products established on the market. However, there are still challenges. Liquid phase exfoliation techniques for instance, can provide high quality products with low defects, but the sheets are small and need surfactants or other additives to avoid restacking, which are difficult to remove and can reduce matrix-interactions and final conductivity. In contrast, graphene oxide lacks electrical conductivity and the outstanding mechanical properties of graphene, but can be dried and re-dispersed and therefor shows significant advantages in terms of processability. Due to its high density of functional groups GO can also be easily functionalized for different purposes.

The electrochemical preparation of graphene combines the best of both worlds. Depending on the process conditions a tunable level of defects and functional groups are introduced that improve processability while maintaining a good electrical conductivity and reasonable sheet size.

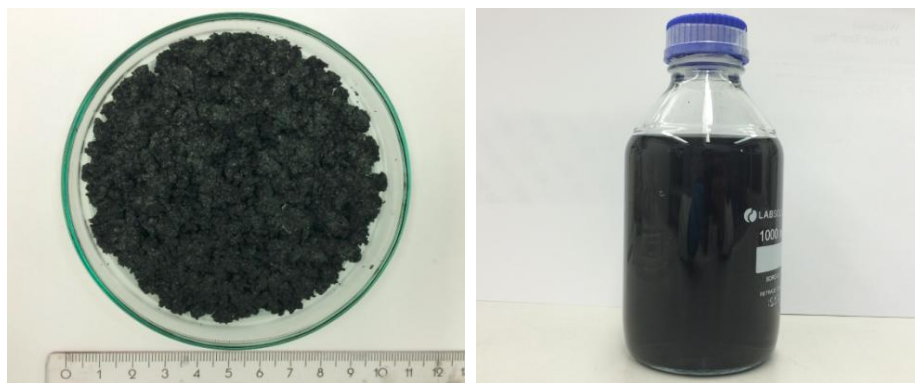


Fig. 1: Photographs of >5g of FLG produced in 15 min at lab-scale and a (surfactant free) dispersion.

References

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