Liquid phase exfoliation of graphite in alcohols

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Abstract

Graphene can be produced by methods like growth on metal substrates by Chemical Vapor Deposition (CVD) or annealing SiC substrates [1]. However, for industrial applications also Liquid Phase Exfoliation (LPE) is a prominent way for a high-yield production of graphene flakes [2]. In this process a dispersion of graphene in a solvent is obtained that can be used as ink for inkjet printing. The top electrode in organic photovoltaic (OPV) solar cells is usually silver deposited by thermal evaporation [3]. Our goal is to replace the silver grid by an inkjet printed graphene pattern, since graphene is transparent with conductivity up to ~10^4 S cm^{-1} [4] and less expensive than silver.
A common solvent for LPE of graphite is N-methyl-pyrrolidone (NMP) [5]. However, it is forbidden to use with most of the print-heads, obviously, due to its high dissolution power. Moreover the reproduction toxicity of NMP can reduce the working place safety.

In this study we will compare exfoliation in different alcohols and glycols like isopropyl alcohol, 1-butanol, 1-pentanol, hexylene glycol, 1,2- and 1,3-propanediol. We tested the exfoliation of graphite by ultrasonication in pure solvents and mixtures. After ultracentrifugation the graphite dispersions are characterized by Raman, SEM, AFM and compared with already published results of LPE in other organic solvents [6]. Figure 1 shows a stable dispersion of few layer graphene in 1-pentanol. Furthermore surface tension and viscosity of the graphene dispersions are measured to be optimized for inkjet printing.

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Figures

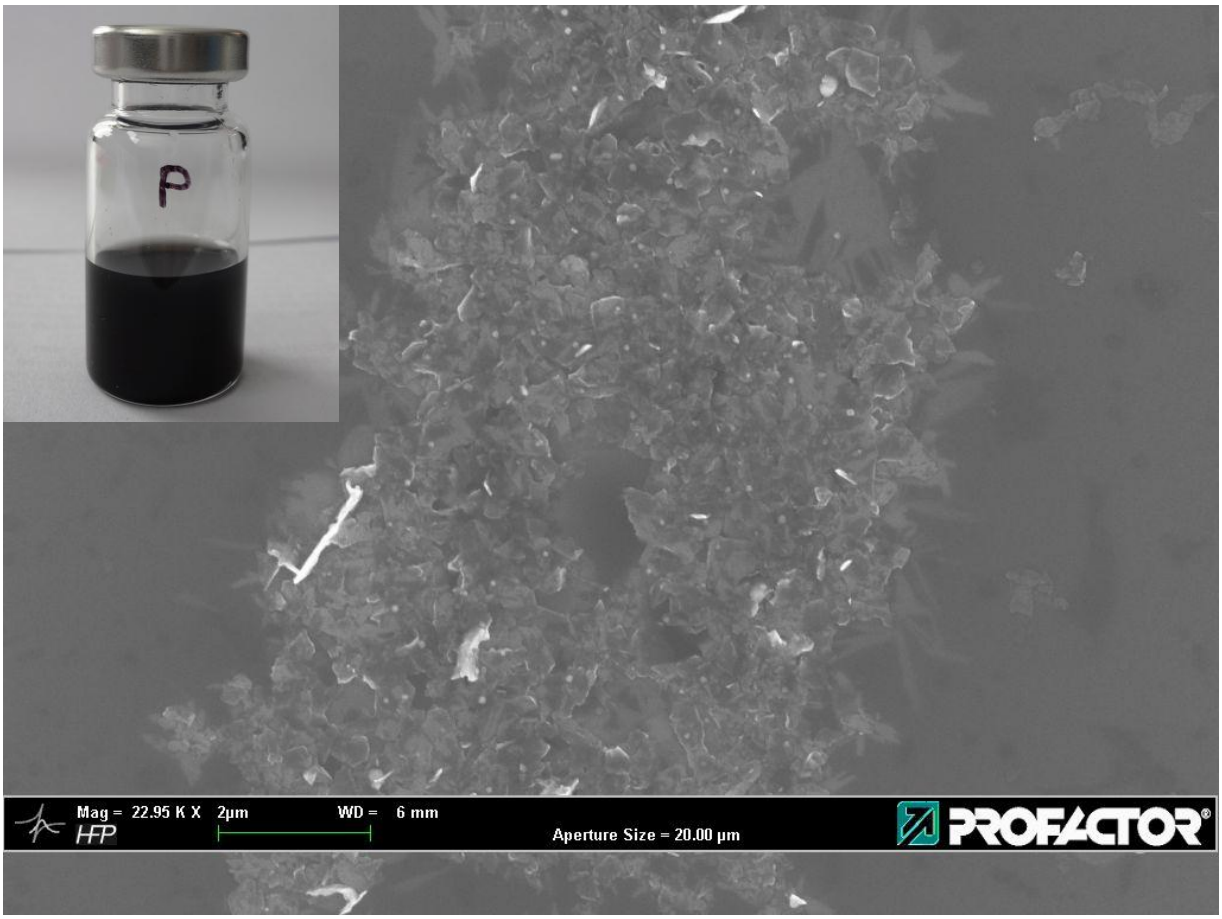

Figure 1 SEM image of graphene/graphite flakes on Si/SiO_2 substrate. **Inset:** 10 ml-Vial with dispersed flakes in 1-pentanol.