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Swelling of graphene oxide membranes in alcohols: effects of molecule size and ageing.

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Swelling of multilayered graphene oxide (GO) membranes is directly related to the size of “permeation channels” which enable diffusion of solvents and solutions. As demonstrated in earlier studies the interlayer distance of Brodie graphite oxides immersed in liquid alcohols increases proportionally to the length of molecules providing multilayered intercalation¹ with interlayer distances up to $\sim 50\text{\AA}$.² However, GO membranes and graphite oxides are materials with different swelling properties.³ Therefore, we performed XRD study of swelling for Hummers graphite oxides and graphene oxide (HGO) membranes in a set of progressively longer liquid alcohols (methanol to 1-nonanol). Both precursor graphite oxides and freshly prepared HGO membranes were found to swell in the whole set of liquid alcohols with increase of interlayer spacing from $\sim 7\text{\AA}$ (solvent free) up to $\sim 26\text{\AA}$ (in 1-nonanol). Pronounced ageing effects were observed for membranes stored on air for periods over 3-6 months with significant sample to sample variations. The HGO membranes and thin films stored at ambient conditions for 5 years showed nearly complete absence of swelling in all alcohols but preserved swelling in water. In contrast, graphite oxide powders showed unmodified swelling in alcohols even after 4 years of air storage. Ageing of GO membranes during on air storage can be one of reasons for strong scatter of permeation properties reported over past years. Standardization of drying and storage conditions is required for better reproducibility of experiments with GO membranes.

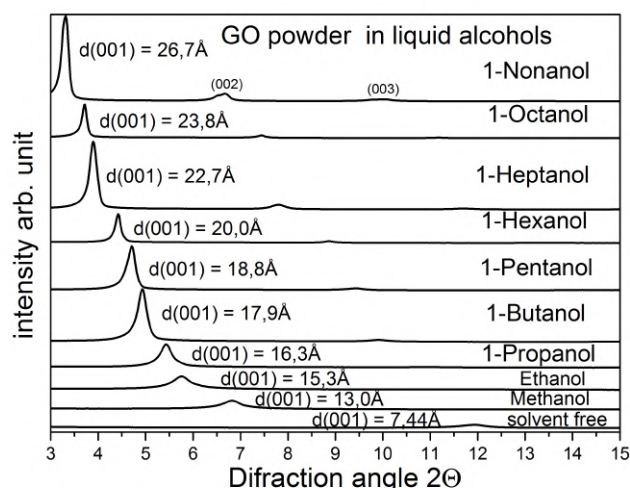


Fig.1. XRD patterns recorded from of GO powder immersed in excess of liquid alcohols (CuKalfa radiation)

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