Inert Liquid Phase Exfoliation of TaS_2

Muhammad Ahmad [1],
Sebastian Klenk [2], Gresa Rexhepi [1], Zdenek Sofer [3], Georg S. Duesberg [2], Claudia Backes [1]
[1]*Physical Chemistry of Nanomaterials, Kassel University, Heinrich-Plett-Str. 40, 34132 Kassel, Germany*
[2]*Institute of Physics, University of the Bundeswehr Munich, Werner-Heisenberg-Weg 39 85577 Neubiberg, Germany*
[3]*Department of Inorganic Chemistry, University of Chemistry and Technology Prague, Technická 5, 166 28, Prague 6, Czech Republic*
muhammad@uni-kassel.de

Abstract

Liquid Phase exfoliation (LPE) is a versatile technique that is used to produce large quantities of 2-dimensional (2D) materials from layered crystals [1]. 2D materials produced by LPE are preferred over other expensive methods where scalability and cost is more important than higher performance. Despite extensive use of LPE for exfoliating a large number of 2D materials, still much attention is needed to study degradation kinetics and thermodynamics under ambient conditions to assess their suitability for real life applications for a number of these 2D materials. In this research we used different stocks of TaS_2 powders and exfoliated 2-dimensional sheets using LPE under inert environment [2], and studied the kinetics and degradation over time. We compare the exfoliated sheets obtained via bath sonication under argon flow and tip sonication in glovebox followed by size selection using liquid cascade centrifugation. We used the exfoliated sheets for film formation using Liquid-Liquid Interface deposition which were subsequently heat treated to convert TaS_2 films into oxides which can be a suitable candidate for using as dielectrics. Then we used electrochemical exfoliation method [3] to get nanosheets with higher aspect ratio and used these sheets to make pinhole free films to assess the suitability of these films as dielectrics.

References

[1] Backes et al., ACS Nano, 10 (2016) 1589-1601
[2] Synnatschke et al., Ultrasonics Sonochem, 98 (2023) 106528
[3] Zhao et al., Chem. Soc. Rev., 53 (2024) 3036-3064