Iranian Journal of Physics Research, Vol. 20, No. 3, 2020
DOI: 10.47176/ijpr.20.3.91124

Correlation of interfacial dilational rheology and processing of 2D Materials liquid crystals: A case-study of graphene oxide liquid crystal phases

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(Received 13 September 2020 ; in final form 21 September 2020)

Abstract
Due to the high aspect-ratio of 2D graphene oxide nanosheets in water, the lyotropic nematic liquid crystal phases of graphene oxide dispersions can be spontaneously formed. The unique visco-elastic characteristics of such liquid crystals can make them a novel category of soft materials. The fundamental insights ensued in this work can be used as a basis for the development of new guidelines for the processing of soft 2D materials by means of vastly available traditional fabrication methods. The concentration range of isotropic, biphasic and nematic phases was determined by employing polarized optical microscopy. Using 2D sheets with a high aspect ratio (over 35000) resulted in the formation of the biphasic region at a concentration as low as 0.05 g/l and the fully nematic region at concentrations higher than 0.25 g/l. Shear rotational rheology and interfacial dilational rheology were employed, as the tools of choice, to correlate the nematic phase formation with the processability and the change in modulus. Our results underpin the argument that the combination of the low concentration of 2D sheets in the supporting media and high elastic modulus can facilitate the use of graphene oxide based formulations for an array of processing and fabrication techniques including but not limited to wet-spinning, electro-spraying, inkjet printing, and 3D printing.

Keywords: 2D materials, graphene oxide, liquid crystal, additive manufacturing, interfacial dilational rheology

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