Monitoring 2D Atomic Layers and Surface Chemistry of Graphene Dispersions Using NMR Proton Relaxation

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Graphene related 2D products are now produced on an industrial scale in either powder form or as a dispersion. Properties such as the number of 2D atomic layers and surface chemistry are known to vary greatly depending on the production method and these can strongly affect the performance of graphene-containing products. Therefore, there is a growing need to develop fast methods for their quality control.

Microscopy and spectroscopy techniques, some of which have recently been standardised (ISO/TS 21356-1), can be combined to characterise thickness and surface chemistry of graphene samples. However, these are time-consuming, require expensive instruments, and can only characterise a small portion of the sample, making them unsuitable for quality control by graphene manufacturers.

We have recently showed that nuclear magnetic resonance (NMR) proton relaxation has the potential to be used for rapid characterisation of graphene samples [1,2]. In this talk we will demonstrate the use of NMR spin-spin relaxation to monitor changes in different structural properties of graphene particles such as particle size, specific surface area, and exfoliation yield. Moreover, we show that the relaxation time is sensitive to the surface chemistry of graphene as well as its solubility in a selected solvent, providing a route to characterise this important property quickly and at low cost. This is important for formulations of graphene flakes in liquids for inks and paints.

NMR proton relaxation exhibits advantages over conventional characterisation techniques including measurement speed, little to no sample preparation, and low costs using benchtop spectrometers. Moreover, this technique could be integrated into an industrial production line, making this a promising tool for graphene quality control. Improved quality control measurements can accelerate adoption of graphene in applications such as energy storage, coatings, and many more.

References

[1] S. Marchesini, K. R. Paton, B. Brennan, P. Turner, A. J. Pollard, Nanoscale,13 (2021), 6389-6393
[2] S. Marchesini, P. Turner, K. R. Paton, B. P. Reed, A. J. Pollard, Nanoscale 13 (2021), 14518-14524

Figures

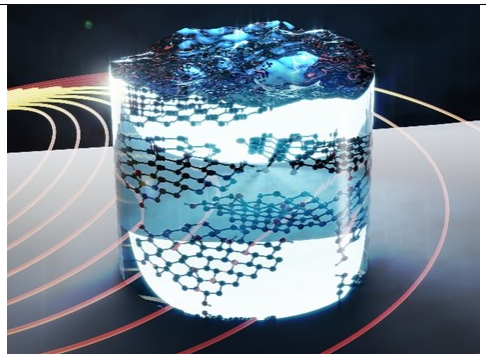

Figure 1: Nanoscale cover image representing graphene flakes in a liquid within the presence of a magnetic field for NMR relaxation measurements.