William Hoffmann

PhD Student

Bristol Centre for Functional Nanomaterials, University of Bristol

Wil holds a Bachelor of Science degree in Chemical Engineering from North Carolina State University. His research experience prior to the BCFN involves surface science of polymeric, metallic, and zeolitic thin films for a variety of applications including biofouling reduction, energy storage and transduction, and crude oil cracking. Whilst obtaining his degree he worked at Sealed Air Corporation developing innovative plastic packaging technologies. His academic interests include 2D materials, self-assembly, and nanoelectronics.

"Laser-induced convection increases error in nanoparticle sizes in Nanoparticle Tracking Analysis"

William H. Hoffmann[1,2,3], Simon R. Hall[1,3], and Henkjan Gersen[1,2]

[1]Bristol Centre for Functional Nanomaterials, University of Bristol, Bristol BS8 1TL, UK.
[2]H.H. Wills Physics Laboratory, University of Bristol, Bristol BS8 1TL, UK.
[3]School of Chemistry, University of Bristol, Bristol BS8 1TS, UK.

Abstract

Nanoparticle Tracking Analysis (NTA) is a technique used in the characterisation of myriad nanoparticle types, including drug delivery vehicles, protein nanoparticles, exosomes, and mesoscopic organic clusters.[1,2] It can measure particles in the range of 10 nm - 2000 nm depending on particle type.[1] The detection limit in NTA is set by the dependence of scattering signal on both particle size and refractive index contrast, with particles that are too small or of too low refractive index contrast scattering insufficient light to be detected. This is problematic for the study of mesoscopic organic clusters, which have relatively low refractive index contrast due to their organic composition and probable solvent content.[3–5] In principle, a higher power laser can be used which proportionally increases the scattering signal and reveals smaller particles if they are present. In this talk, I discuss the effects of laser power on the sizing data derived from NTA for calibration particles and mesoscopic clusters of flufenamic acid in ethanol. Whilst a higher laser power reveals more particles when they are close to the detection limit, the particle residence time changes due to laser-induced convection. The reduced residence time decreases the number of tracks available for individual particle size determination, which increases the uncertainty in the derived size. The

competing effects of increasing laser power, which reveals smaller particles, and convection, which modifies the size distribution, present a challenge in the interpretation of NTA data. However, the detailed understanding of laser-induced convection permits more robust size characterisation of mesoscopic organic clusters, which play a key role in two-step nucleation theory.[6]

References

1 Bob Carr and Matthew Wright. Nanoparticle Tracking Analysis: A Review of Applications and Usage. Technical report, 2013.

2 Monika Warzecha, Mohammad S. Safari, Alastair J. Florence, and Peter G. Vekilov. Mesoscopic Solute Rich Clusters in Olanzapine Solutions. Crystal Growth & Design, 17:6668–6676, 2017.

3 Anna Jawor-Baczynska, Barry D. Moore, Han Seung Lee, Alon V. McCormick, and Jan Sefcik. Population and size distribution of solute-rich mesospecies within mesostructured aqueous amino acid solutions. Faraday Discussions, 167:425–440, 2013.

4 Monika Warzecha, Rui Guo, Rajni M. Bhardwaj, Susan M. Reutzel-Edens, Sarah L. Price, Dimitrios A. Lamprou, and Alastair J. Florence. Direct Observation of Templated Two-Step Nucleation Mechanism during Olanzapine Hydrate Formation. Crystal Growth & Design, 17:6382–6393, 2017.

5 Michael Svärd, K. Renuka Devi, Dikshitkumar Khamar, Donal Mealey, Dominic Cheuk, Jacek Zeglinski, and Åke C. Rasmuson. Solute clustering in undersaturated solutions-systematic dependence on time, temperature and concentration. Physical Chemistry Chemical Physics, 20:15550–15559, 2018.

6 Peter G. Vekilov. Nucleation. Crystal Growth and Design, 10(12):5007–5019, 2010.