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A combined SANS and USANS study to investigate the structure of solid lipid nanoparticles

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Solid lipid nanoparticles (SLNs) have been extensively investigated as drug carrier systems since their inception in the 1990s. These are emulsions when prepared at high temperature and crystallize predominantly into SLNs upon cooling. The details of their ultrastructure are poorly defined. Previously, our group reported a novel microwave-assisted microemulsion-based technique to prepare SLNs with radii of approximately 150 nm. To understand the detailed internal structure of these SLNs, contrast variation ultra-small angle neutron scattering (USANS) and small angle neutron scattering (SANS) experiments were conducted on suspensions of hydrogenated stearic acid SLNs in D2O. Together, SANS and USANS gave a combined Q range of 0.000047 to 0.6 Å^−1 (corresponding to a size range of 1 nm - 15 μm). The extended Q range used in this study allowed an extensive study of the hierarchical structure of SLNs. The combined data are consistent with the SLNs having an oblate structure at the microscale level, intermediate between rods and lamellae, with roughened surfaces. At the nanoscale level, the results were consistent with the SLNs having an ellipsoidal shape intermediate between spheres and rods, with a crossover from mass fractals to surface fractals. The elucidation of this structure is particularly important given that the structure influences the stability and drug release properties of the nanoparticles. These results will assist in the development of systems with desired shape and properties.

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