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Probing the complex loading-dependent structural changes in ultrahigh drug-loaded polymer micelles by small-angle neutron scattering

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Drug-loaded polymer micelles or nanoparticles are being continuously explored in the fields of drug delivery and nanomedicine. Commonly, a simple core–shell structure is assumed, in which the core incorporates the drug and the corona provides steric shielding, colloidal stability, and prevents protein adsorption. Recently, the interactions of the dissolved drug with the micellar corona have received increasing attention. Here, using small-angle neutron scattering, we provide an in-depth study of the differences in polymer micelle morphology of a small selection of structurally closely related polymer micelles at different loadings with the model compound curcumin. This work supports a previous study using solid-state nuclear magnetic resonance spectroscopy and we confirm that the drug resides predominantly in the core of the micelle at low drug loading. As the drug loading increases, neutron scattering data suggests that an inner shell is formed, which we interpret as the corona also starting to incorporate the drug, whereas the outer shell mainly contains water and the polymer. The presented data clearly shows that a better understanding of the inner morphology and the impact of the hydrophilic block can be important parameters for improved drug loading in polymer micelles as well as provide insights into the structure-property relationship.

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