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Forming Nanoparticle Monolayers at Liquid-Air Interfaces by Using Miscible Liquids[1] JIAYANG HU, DATONG ZHANG, KATHLEEN M. KENNEDY, IRVING P. HERMAN, Department of Applied physics and Applied Mathematics, Columbia University — The usual standard way to form monolayers (MLs) of nanoparticles (NPs) is to drop-cast a NP dispersion in one solvent onto a second immiscible solvent; after the upper solvent evaporates the NP MLs can be transferred to a solid substrate by liftoff. We show that this previously-universal solvent immiscibility is not necessarily a barrier in forming NP MLs at liquid surfaces, and large-scale, continuous, close-packed, hexagonally ordered NP MLs can self-assemble at liquid-air interfaces when some miscible solvent pairs are used instead. We demonstrate this by drop-casting an iron oxide NP dispersion in toluene on a dimethyl sulfoxide (DMSO) liquid substrate. The NPs are energetically stable at the DMSO surface and remain there even with solvent mixing. Excess NPs coagulate and precipitate in the DMSO, and this self-limits NPs at the surface to approximately 1 ML. The ML domains at the surface nucleate independently, which is in contrast to ML growth at the receding edge of the drying drop, as is common in immiscible solvent pair system. We also show that MLs can be formed by using other miscible solvent pairs such as benzene/DMSO and fluorobenzene/DMSO, and a wider range of NPs.

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