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Estimation of drying length during particle assembly by convective deposition

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Abstract

Convective deposition is a scalable method for directing colloidal self-assembly. Ordered layers of deposited particles have numerous applications as advanced materials for optical devices and membranes. Over the past 20 years, a simple mass balance derived by Dimitrov and Nagayama has been widely used for relating film thickness to deposition velocity, suspension concentration and evaporation rate and particle size. This balance works well for a small range of deposition velocities, but it fails to predict the coating thickness over a broader range. Specifically, in this balance the length scale related to drying is not well-posed and the drying length generally thought to be roughly constant. This work derives an analytical expression for the drying length in convective deposition for a more general set of conditions by considering the resistance to flow through the deposited particles. This analysis allows prediction of coating thickness over a wider range of velocities from low density coatings to multilayer particle assemblies.

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