

ROLE OF SOLUBLE POLYMER BINDER ON PARTICLE DISTRIBUTION IN A DRYING COATING

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Particulate coatings are used for various applications, such as paper coatings and functional layers in fuel cells and batteries. These coatings are prepared by depositing a suspension of particles in a liquid, typically water, and then drying. Polymer binder is frequently added to the suspension to provide the coating with mechanical strength and adherence. Coating properties (e.g., scratch resistance, color, reflectivity) are influenced by coating microstructure, especially particle distribution. Since the microstructure develops during the drying process, it is essential to understand the influence of the three suspension components (liquid or solvent, soluble polymer, particle) on the development of transient concentration profiles during drying.

In past research¹, a model for particle concentration as a function of position and time in a drying coating was developed for the case of a particle suspension with no polymer binder present. It was shown that three effects control particle distribution: sedimentation, evaporation and diffusion; and two dimensionless numbers, the Peclet number, Pe , and the sedimentation number N_s , can be used to predict the distribution. The results were presented in drying regime maps that graphically show the predicted microstructure evolution for a given particle system, drying condition and the initial concentration. Experimental particle distributions revealed by cryoSEM experiments matched the predictions well.

Here, we focus on the effects of a soluble polymer binder on the structure development in a drying particulate coating. A binary model for the polymer-solvent system was created in order to track the polymer concentration within the coating. Since polymer and solvent have approximately the same density, sedimentation was neglected. In the three-component system (solvent, soluble polymer, particle), the local polymer concentration determines the viscosity of liquid and hence influences both the sedimentation and diffusion of the particles. Therefore, the presence of the polymer is expected to shift the regime limits within the drying regime maps.

References:

1. C.M. Cardinal, Y.D. Jung, K.H. Ahn, L.F. Francis, "Drying regime maps for particulate coatings", AICHE Journal (2010)

¹ Unpublished. ISCST shall not be responsible for statements or opinions contained in papers or printed in its publications.