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Drying, Film Formation and Open Time of Aqueous Polymer Dispersions

In environmentally-friendly varnishes and paint formulations, aqueous polymer dispersions form one alternative to the established polymer solutions based on organic solvents.
Unfortunately, until today, the application and protection properties of aqueous coatings, e.g. their Open Time, are poor compared to the ones of the solvent-based formulations. Open Time is the time period after the application of a coating layer, during which corrections can be done on the film, without that application defects like lap lines or the stroke of the brush will remain visible in the final dry coating.

Three main reasons can be identified for the “minor” Open Time properties of waterbased paints and varnishes:

1. During drying of aqueous polymer dispersions the polymer particles form an ordered packing structure and start to deform. Film formation of aqueous polymer dispersions is by irreversible particle contact and interdiffusion of polymer chains. From this moment a redispersion of the polymer particles and a correction of application defects by application of a new coating layer is no longer possible.
2. Waterbased formulations dry horizontally inhomogeneous. Drying is faster at the edge of the film due to a larger evaporation area and often reduced film thickness. This will lead to the formation of horizontal water concentration gradients in the film. Capillary suction will cause a horizontal mass flow in the film. As a result of lateral inhomogeneous drying lap lines will be visible in the final coating.
3. During drying an exponential increase of the viscosity of aqueous polymer dispersions is observed. This will retard or completely hinder the leveling of application defects in the freshly applied coating. The result is that the stroke of the brush will be visible in the final dry film.

To improve the application properties of aqueous paint formulations it requires a fundamental understanding of the drying and film formation mechanism of colloidal dispersions.

By means of Inverse-Micro-Raman-Spectroscopy, it is possible to measure the water content in horizontal and vertical direction of thin polymer films online during drying at a high time and space resolution. Rheological investigations help identify the dependence of the viscosity function on the water content of the film.

The contribution will show detailed results about the investigation of the different aspects of Open Time of waterbased polymer dispersions. In this study, experimental data like the measured concentration profiles in the film and the rheological data will be compared with model calculations.