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Wetting of Polymer surfaces: Effect of Swelling and Droplet Evaporation

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Wetting of polymer coating is of specific interest for the adhesion of cells or proteins and the technical control of wetting. Cells or proteins are in a physiological environment, i.e. an aqueous solution and the polymer coatings are often hydrophilic or partially hydrophobized. Therefore, the coatings often swell in water which changes the wettability during the wetting process. This complex process is not well understood. A few studies on the water wettability of polyelectrolyte-coated surfaces exist [e.g. 1-4]. Tay et al. found an effect of osmotic pressure on the contact line in wetting studies of charged and uncharged polymeric coatings [5]. That makes the wetting process rather complex, since different time scales but also different length scales come into play. The adaptive surface needs a certain time until the swelling process is finished. The swelling doesn't stop at the three phase contact line, and the liquid sucks laterally into the region in contact with the gas phase. Hansen and Miotto called that its peripheral thickness [6]. This deforms the surface and the contact line is not well-defined anymore.

We studied the wettability by water of polyelectrolyte mono- and multilayers with different polycations or polyanions as the outermost layer using the sessile drop technique [3]. Measurements in a water-saturated atmosphere and in ambient conditions [40% relative humidity (r.h.)] are made to study the effect of swelling and evaporation on the contact angle. It is found that these effects strongly depend on the outermost layer of the polyelectrolyte coating. For several kinds of polyelectrolytes as outermost layer the polyelectrolyte-coated surface can be equilibrated by pre-swelling in saturated vapor. Depositing a water droplet leads to a fixed contact angle against vapor. For other types polyelectrolytes as the outermost layer the water contact angle also indicates a change in the swelling state when the pre-equilibrated film is directly in contact with liquid water, resulting in a decrease in contact angle with time. The studies show that a highly sophisticated interplay between hydrophobic backbone and charge density determines the wetting behavior, irrespective of the sign of surface charge. The stability of the wetting film on polyelectrolyte surface is analysed by disjoining pressure isotherms [7]. There surface charge seems to be the most dominant factor for stability of the wetting film.

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