Adhesion on modified electrodes – mechanisms and applications

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Adhesion phenomena are not only determined by the nature of the surface, such as presence of functional groups or its hydrophobicity/hydrophilicity, but are also mediated by long-ranged electrostatic forces. Understanding and controlling the latter provides a versatile approach to tune adhesion behavior for a number of applications, such as micro- and nanomanipulation in biological systems or for micro-electromechanical devices (MEMS).

The diffuse layer properties of modified electrodes can be varied by means of the externally applied potential and the resulting electrostatic interaction forces can be determined by direct AFM measurements [1]. Those in turn can be described by theoretical models [2]. Moreover, direct force measurements with the colloidal probe technique allow relating these long-range forces with the adhesion behavior of a colloidal particle on the electrode surface (cf. Figure 1). By varying the functional groups terminating the self-assembled monolayer (SAM) not only the influence of the electrochemical potential but also of the surface chemistry can be probed (cf. Figure 1, insert).

Quantitative analysis of the adhesion forces shows that the electrostatic interaction dominates the adhesion for rough colloidal silica particles. However, solvent exclusion and electrocapillarity represent additional contributions, albeit to a lower degree. This approach of tuning the adhesion forces by potentiostatic control of the electrode can be readily utilized for micromanipulation of colloidal particles (cf. Fig. 2).

![Fig.1 Force profiles upon retraction between a colloidal silica particles and a methyl-terminated SAM under potentiostatic control. The resulting pull-off forces are shown in the insert](image1)

![Fig. 2 Manipulation process at two different steps](image2)