A3: Hydrogel-Particle Based Adhesion-Sensors

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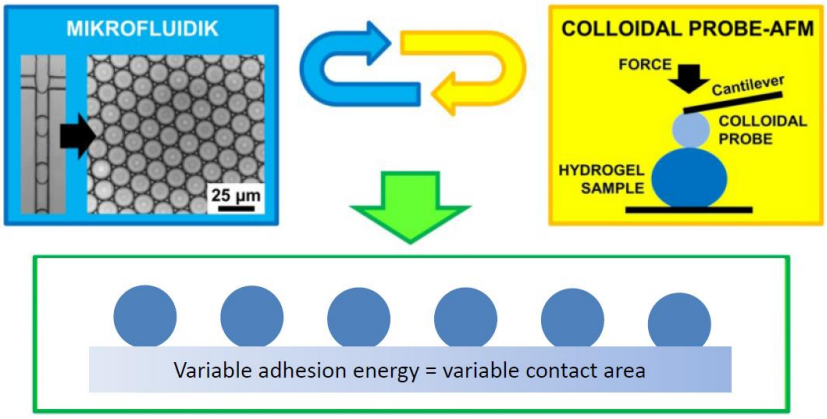
Motivation:

Measuring adhesive interactions on the nanoscale usually requires complex techniques, e.g. atomic force microscopy or magnetic-/ optical tweezers. This projects aims to establish an alternative approach combining high sensitivity with massive parallelization, hence allowing fast, combinatorial investigations. Therefore, we use hydrogel probe particles with known mechanical properties and functionalized surfaces. The adhesion – in contrast to be commonly inferred from detachment forces – can be measured (optically or electrically) by the contact area of the particle and the adhesive surfaces. The accuracy can be improved by orders of magnitude compared to established techniques, concurrently the instrumental effort decreases since no force measurements are necessary.

Status of research and our preliminary work:

Hydrogel microparticles with defined size and degree of crosslinking can be prepared by droplet microfluidics employing thermal as well as UV induced polymerization (in cooperation with Thiele) [1]. The Fery group has many years of experience in characterizing mechanical and interaction properties of soft matter particles by atomic force microscopy based methods [2]. In addition, evidence has already been found that the contact area of soft particles can be used directly to determine the adhesion energy [3].



Scientific questions and project goals:

The overall objective of the project is the development of novel test particles, which are suitable for the investigation of adhesive interactions. Hydrogel particles of identical size and degree of crosslinking can be microfluidically prepared and surface functionalized. For this purpose, the preparation of hydrogels by polymerization of polymer precursors and crosslinkers in monodisperse water-in-oil (W/O) emulsion droplets is used in microfluidic flow cells. Employing the Colloidal Probe AFM technique, the mechanical properties of the particles can then be examined and the particles are “calibrated”. Then the functionalized particles can be brought into contact with adhesive surfaces. Since the mechanics of the particles are known, the adhesion energy of the particles on the surfaces can be directly derived from the observed contact area [3]. This method is particularly suitable for combinatorial investigations in which adhesion-promoting molecules are systematically varied, as arrays of particles enable the parallel investigation of a large number of adhesion situations. In addition, dynamic changes in the adhesion energy can be observed.

Literatur:

[1] Heida, T.; Neubauer, J. W.; Seuss, M.; Hauck, N.; Thiele, J.; Fery, A., *Macromol. Chem. Phys.* **2017**, 218, 1600418.

[2] Seuss, M.; Schmolke, W.; Drechsler, A.; Fery, A.; Seiffert, S., *ACS Applied Materials and Interfaces* **2016**, 8 (25), 16317 - 16327.

[3] Erath, J.; Schmidt, S.; Fery, A., *Soft Matter* **2010**, 6 (7), 1432-1437.