MODELLING OF SURFACE FORCES BETWEEN TWO HIHGLY ROUGH SURFACES USING AFM TOPOGRAPHY SCANS

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Since 2011, the CRC920 has been working on metal melt filtration using ceramic foam filters (CFF) to significantly improve metal quality by separating particulate impurities. It was found that, in addition to the chemical composition of the CFF, its surface roughness also plays a significant role in adhesion, as additional effects occur due to poor wettability with the melt, namely a generation of so-called nanobubbles [1].

The properties of the metal melt (e.g. opacity, temperature) do not enable a direct investigation of adhesive forces under real conditions. Although the physical description of a few surface forces is now quite exact for ideally smooth, homogeneous surfaces, it is more difficult for rough or inhomogeneous surfaces: Some models use assumptions which consider only convex roughness, others vary parameters until they fit the experimental data. Also, the influence of coatings is not taken into account. These approaches do not allow universal use of the models, so repeated measurements are necessary in order to get a correct data basis.

Within the context of CRC920, a water-based model system that mimics the poor wetting properties of metal melt via silane coating of the filter and inclusion particle surfaces was developed in order to precisely determine the adhesive forces as a function of roughness using atomic force microscopy (AFM). Measurement results of the highly rough surfaces show, if only van der Waals (vdW) forces act as attractive contribution (i.e.no silanization), the adhesive forces decrease with increasing roughness. The situation is exactly the opposite after silanization, i.e. reduced wettability, which can be attributed to additional capillary interactions [2]. But, the influence of the silane layer on measured forces could only be estimated very roughly so far.

The possibility of scanning topographies of the two surfaces in high resolution using AFM and the implementation of the Dagastine layer model [3] via Matlab allows the comparison of simulated adhesive forces with experiments and show good agreement for the vdW forces. A simulated contact of an inclusion particle with a nanobubble-covered filter surface shows why previous models calculate values that are significantly too large. This enables a more precise description of the metal melt filtration process.

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