Contribution ID: **692** Type: **not specified**

P2.120 The adhesion of tungsten dust on rough tungsten surfaces

Tuesday, 18 September 2018 11:00 (2 hours)

Adhesion plays a pivotal role in numerous aspects of tokamak-generated dust such as in-situ removal techniques, post-mortem collection activities, resuspension during loss-of-vacuum accidents and in-plasma remobilization. Due to insurmountable difficulties in the theoretical treatment of the interaction between technical (rough, polycrystalline, adsorbate covered) surfaces, adhesive or pull-off force measurements for reactor relevant materials are imperative.
Recent measurements of the adhesion of spherical micron W dust (R_d⊠5-15µm) on planar W surfaces (R_q⊠10-100nm) revealed the importance of surface morphology. Due to nano-roughness: (i) Adhesion is not dominated by metallic bonding interactions but by London dispersion forces, implying that the Van der Waals expression can provide a zero-order estimate of the pull-off-force. (ii) Adhesion is not deterministic but acquires a statistical nature and is better described by cumulative distribution functions. In particular, the pull-off force behaves as a log-normally distributed random variable.
However, in situ tokamak roughness is characterized by much higher root-mean-square values. Surface roughness of the order of the contact radius (R_q~1µm) should lead to a respectable decrease of the mean value of the measured pull-off force and increase of its relative standard deviation. To quantify adhesion for tokamak-relevant surfaces, we have performed systematic pull-off force measurements for W dust deposited in a controlled manner on rough planar W surfaces (R_q~1µm). Monodisperse spherical W dust (R_d=9,15µm) was adhered to rough W samples through impacts below the sticking threshold. The samples were then inserted in an electrical mobilization setup that allows the measurement of the pull-off force by exerting an electrostatic force of well-known magnitude. The measurements revealed a ~50% reduction in the mean value and a ~100% increase in the relative standard deviation of the pull-off force for rough surfaces (R_q⊠1µm) compared to smooth surfaces (R_q⊠10nm). Despite these differences, the pull-off force still follows the log-normal distribution.

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Session Classification: P2