Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Adhesion and Wetting in Soft Polymeric Systems[1] ANDREY DOBRYNIN, ZHEN CAO, Univ of Akron, MARK STEVENS, Sandia National Laboratories — We have developed a generalized model of particle/surface interactions describing adhesion and wetting phenomena. We show that for an elastic nanoparticle with radius $R_{\rm p}$ and shear modulus $G_{\rm p}$ interacting with an elastic substrate having shear modulus $G_{\rm s}$ the crossover between adhesion and wetting-like behavior is determined by a dimensionless parameter $\beta \propto \gamma^*(G^*R_p)^{-2/3}W^{-1/3}$. In the limit of small values of the parameter β <<1, our model reproduces JKR model for particle adhesion on elastic substrates (adhesion regime). However, in the opposite limit, β>>1, the capillary forces play a dominant role and determine particle/substrate interactions (wetting regime). We extended our approach to describe the detachment of rigid nanoparticles from elastic surfaces. Simulation results confirm that the detachment force, f^*, depends on a dimensionless parameter $\delta \propto \gamma_s(G_sR_p)^{-1/3}W^{-2/3}$, which corresponds to the ratio of the surface energy of the neck and the substrate elastic energy. In the case when δ <<1, the critical detachment force approaches a critical value calculated in the framework of the JKR model, $f* = 1.5\pi W R_p$ (JKR regime). However, in the opposite limit, the critical detachment force scales as$f* \propto \gamma_s^{3/2}R_p^{1/2}G_s^{-1/2}$ (necking regime). All simulation data can be described by a crossover function $f* \propto \gamma_s^{3/2}R_p^{1/2}G_s^{-1/2}\delta^{-1.89}$.

[1]NSF DMR-1409710

Zhen Cao
Univ of Akron

Date submitted: 05 Nov 2015 Electronic form version 1.4