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Influence of collision velocity on triboelectric charging of polyolefin particles

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The triboelectric charging of electrically insulative particles causes operational problems in many industrial processes. For example, it causes unwanted particle adhesion to reactor walls during the production of polyolefins in gas-phase fluidized beds, which leads to the formation of wall sheets and reactor shutdown. The underlying mechanism of triboelectric charging is, however, not fully understood, and current mathematical models based on Discrete Element Method (DEM) have several limitations. These include: (i) the models neglect particle surface roughness; (ii) the large computational cost of DEM simulations. Therefore, we developed a DEM particle-wall collision model that includes particle surface roughness, and we then focused on reducing the computational time. Particles were geometrically described as smooth spherical cores with semi-spherical asperities on their surfaces. Existing contact mechanics models were then modified to include the effects of this surface roughness. Saturation charges were evaluated based on particle size, material properties, surface roughness, and collision velocity. Our results show that surface roughness has an important effect: saturation charge is a function of collision velocity. This is supported by experimental data and cannot be explained by models that neglect surface roughness. Moreover, based on the results of model parametric studies, we show that assuming all surface asperities have the same height, a single function of all input parameters can be used as a surrogate model, thus significantly reducing the computational time.