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On the formation of rolling particles during sliding contact

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The process of wear particle formation at the sliding contact between rough surfaces has an apparent contradiction: The material exchange between sliding surfaces requires a strong adhesion between surface asperities, whereas the detachment of final wear particles demands a weak adhesion between worn fragments and sliding surfaces. Here, using a coarse-grained numerical technique, we study the complete process of wear particle formation (i.e., nucleation, evolution, and detachment) during adhesive sliding contact. We show that discrepant experimental and theoretical wear observations can be attributed to different stages of the wear particle formation. In particular, we address the opposite contribution of adhesion into the formation and detachment processes of wear particles. Our simulations reveal that reducing adhesion diminishes the adhesive wear in three ways: (i) reducing the probability of wear particle formation, (ii) increasing the required energy per unit volume of removed materials (i.e., decreasing the energy efficiency for particle formation), and (iii) alleviating the growth of formed wear fragments.

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