Ultra cleaning with drop impact

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Abstract

Although cleaning of surfaces with high-pressure spray has been used for many years in various industrial fields such as microelectronics, the mechanism by which dust particles break off from the surface upon drop impact is still not understood. In this work, we propose a new model to quantify the cleaning efficiency by a spray by combining i) a mechanical balance between the adhesion particles / surface of capillary origin and shear related to the spreading of the drop and ii) a statistical analysis of the effective impacts. This model, which involves a large number of different variables, specific to the particles or the surface, the distribution in size and speed of the drops of the spray, the nature of the fluid used or that of the vapor surrounding the surfaces was confronted with all our experimental data successfully. This proves that the predominant physical mechanism in particulate removal is related to the large number of contact lines (solid / liquid / gas) impacting the surface at high speed. These multiple lines of contact create a multitude of shock waves at the scale of particles that are like devastating tidal waves sweeping everything in their path. However, as soon as the surface is no longer smooth, or in the presence of textures, the efficiency of the spray cleaning drops dramatically.

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