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Dynamics of Fluid Flow and Heat Transfer during the Impact of a Drop on a Substrate

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Widespread use of sprays in many industrial applications has motivated many studies. These applications range from jet-ink printers which involves no heat transfer, to spray cooling of hot surfaces. Other important applications such as thermal spray deposition of wear or corrosion resistant and thermal barrier coatings involves the impact of molten metal or oxide droplets on a metallic surface. Dynamics of the impact is crucially important since the microstructure of produced coatings depend to a large extent on the shape of the splats that are formed by the impact on the surface and on previously deposited droplets.

Impact of liquid drops on a surface is a complex problem which involves interfacial fluid flow, motion of the 3-phase contact line, and heat transfer between the liquid drop, substrate, and ambient air. In case of molten metals and ceramics, the impact also involves solidification.

In this paper, a review of the current state of theoretical and computational advances in predicting fluid flow and heat transfer during the deposition of droplets on a surface is presented. Models based on VOF (volume of fluid), LS (level set), combined LS-VOF, advecting normal algorithms, as well as SPH (smoothed particle hydrodynamics) will be briefly presented and their applications will be discussed.