DYNAMICS OF LIQUID DROP IMPACT ON LIQUID SURFACE AND ALLIED INTERFACIAL TRANSPORT PHENOMENA

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ABSTRACT

Drop impact dynamics is an emerging area of research because of its several natural and industrial applications. Now, conventional transport processes such as momentum, mass and heat transport are associated with the dynamics of drop impact on liquid surface. The objective of the thesis is to scientifically enrich the field of drop dynamics and its allied transport processes from the experimental observations using a high-speed camera. First, it is shown that surface tension differences between liquid drop and liquid pool created Marangoni stress at the interface which creates drop necking and eventually leads to partial coalescence and secondary droplet generation. The variation of number in secondary droplet generation is also controlled by the drainage of airfilm which is dependent on Marangoni velocity at the interface. Next, a comprehensive study of interfacial chemical reaction with phase change has been performed for chemically reactive sodium alginate drop impact on calcium chloride liquid pool. The crosslinking chemical reaction between these two reacts forms calcium alginate gel which is generated as three-dimensional network structure. The crater growth is modelled to determine the gelation properties. Also, the hydrodynamic analysis has been performed to explore more about the process. The alginate drop concentration affects the drag enforced on the drag during the solidification process. After that the drop impact gelation process has been investigated by addition of heat transfer from liquid pool. It is established that the migration of calcium ions are increased and initialisation of gelation depends on the Leidenfrost Effect. Finally, the gelation process is studied during drop impact on reactive liquid film where, the effect of solid surface becomes prominent on the solidification process. The major drop impact outcomes are splashing, jetting and liquid lens formation which governs in different shaped gel formation. The gelation rate becomes highest for a specific liquid film thickness. The spreading induced solidification and capillary wave formation both helps in mixing and effective crosslinking. Also the boundary layer formation over the solid surface during drop spreading contributes in gelation process. The extent of gelation is evaluated from the impact pressure and energy dissipation under the liquid film. Broadly, the gelation process is analyzed from drop dynamic perspective which can be used in further synthesis technology and different encapsulation applications. Finally, the possible research directions have been identified from the work conducted in the thesis.

Keywords: Marangoni stress, coalescence, interfacial chemical reaction, gelation, Leidenfrost Effect, capillary wave, boundary layer