Hot melt ink-jet printing

Hot Melt Ink-Jet Printing

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Introduction

Hot melt ink-jet printing employs an ink which solidifies after impact on a substrate unlike water based inks which rely on evaporation of solvent for drying. Due to solidification during droplet spreading, it may be possible to control the final spread diameter and height of the droplet. Also, fluid elasticity has been found to have effect on the recoil behavior of the droplet [1]. This suggests that an ink based on polymer melt can be a better alternative to water based inks. Moreover, such an ink would not pose the problem of bleeding i.e. penetration of ink through to the other side of paper which has to be considered for water based formulations (Fig.1).

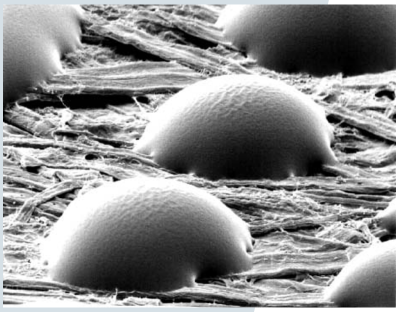

Figure 1 *A SEM photograph of phase-change ink drops on the surface of a bond paper;* From [2].

What happens when a liquid droplet impacts a solid surface (see Fig.2) is also of relevance to many other processes such as spray coating, spray cooling, solder jet technology etc. of which it forms a basic element.

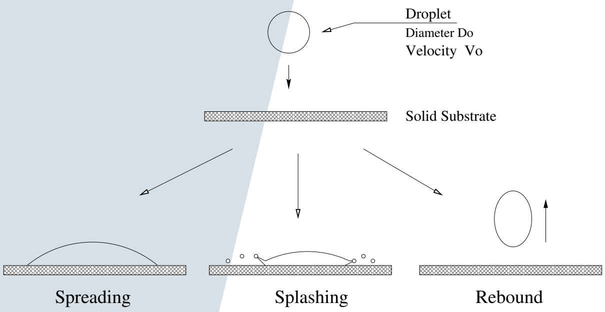

Figure 2 *Possible Outcomes of a droplet impact on a solid surface.*

An understanding of fluid dynamics and heat transfer accompanied with or without phase change, if any with these processes is crucial in the selection of proper materials and in optimizing operating conditions.

Objectives

- ☐ Study the role of melt solidification on the extent of spreading
- ☐ Determine the effect of fluid visco-elasticity on impact behavior

Numerical Modeling

Challenges in this approach:

- ☐ Moving contact line
- ☐ Extreme deformation in a very short time
- ☐ Moving solidification front (Vsi)
- ☐ Free boundaries
- ☐ Temperature and shear-rate dependent droplet material rheology
- ☐ Thermal contact resistance

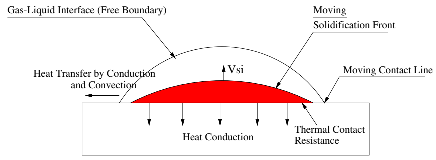

Figure 3 *Schematic representation of a droplet solidifying during spreading.*

A Physically realistic treatment of some of the aforementioned problems is possible within the framework of the Diffuse Interface Model [3].

Experimental

Challenges in this approach:

- ☐ Small droplet size (d_0) $\mathcal{O}(30\mu m)$
- ☐ Short time scale $\mathcal{O}(ms)$
- ☐ Discerning final solidification time

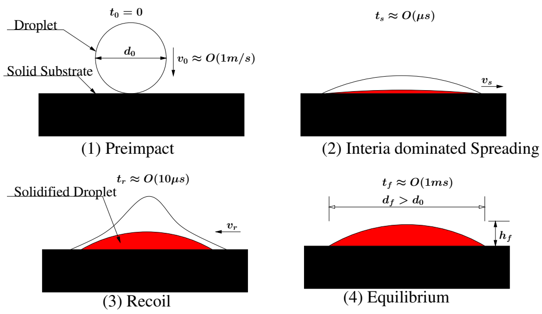

Figure 4 *A typical sequence of events after the impact of a hot droplet onto a cold solid surface.*

Use of a high speed camera (approx.20000 frame/s) and a polymer (*as yet unknown*) which possess different visually perceptible colors in solid and in melt state may provide the solution.

Summary

Modeling of non-isothermal impact of a visco-elastic droplet using the Diffuse Interface Model along with experimental validation is proposed.

References:

[1] Bergeron, V., Bonn, D., Martin, J.Y. and Vovelle, L., Controlling droplet deposition with polymer additives, *Nature*, **405**, 772-775 (2000).

[2] Le, H.P., Progress and Trends in Ink-jet Pinting Technology, *J. Image Sci. Tech.*, **42**, 49-62 (1998).

[3] Verschueren, M., A Diffuse-Interface Model for Structure Development in Flow, Ph.D. thesis, Eindhoven University of Technology, the Netherlands (1999).

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