Wetting and hydration of a soluble thin film

Julien Dupas[1], Emilie Verneuil[1], Laurence Talini[1], Laurent Forny[2], Marco Ramaioli[2] and François Lequeux[1]
[1] *PPMD Laboratory, ESPCI, Paris, France*
[2] *Nestlé Research Center, Lausanne, Switzerland*

Upon pouring a dehydrated food powder onto the surface of water to obtain a beverage, several phenomena condition the quality of the beverage obtained: powder wetting, water penetration into pores, sinking, dispersion and dissolution.

A classical way to study the wetting of a solid surface consists in observing the kinetics of spreading of a liquid droplet. The spreading of a water droplet deposited on an inert, insoluble surface was studied extensively and the laws that relate the contact line velocity U to the contact angle are well established [1,2].

When dealing with a soluble surface the mass transfers between the surface and the liquid strongly condition the contact line motion. Tay *et al.*[3] showed that the wetting is conditioned by three mass transfers (Fig.1a): water evaporation from the droplet and condensation ahead of the contact line, diffusion of water in the polymer layer and solute diffusion from the soluble surface to the droplet. When evaporation and condensation dominate the hydration and layers are thin, the contact angle depends on the product of layer thickness and contact line velocity (eU).

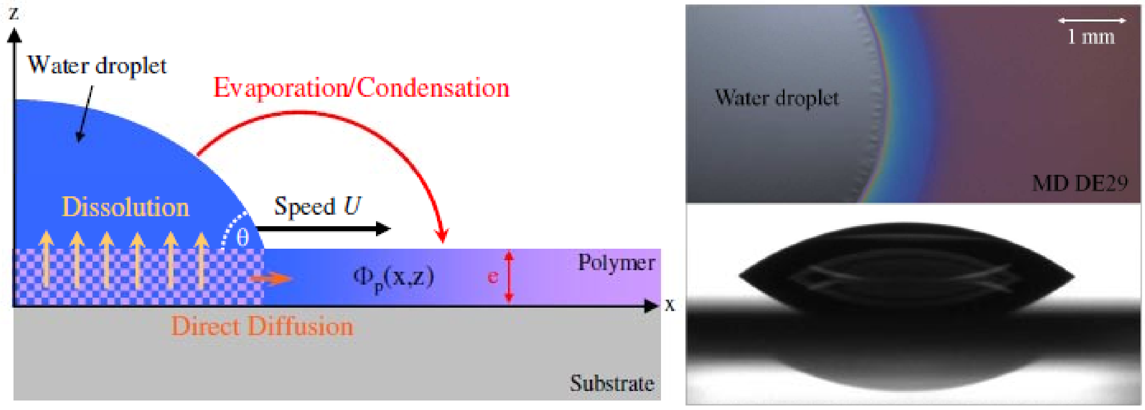

Fig. 1. (a) Different transfers involved in the spreading of a water droplet onto a soluble food polymer (b) Typical pictures acquired by the top view and lateral cameras of the spreading set-up (water onto a 250 nm-thick layer of maltodextrin DE29)

In this work we study the spreading of a water droplet on maltodextrin DE29 thin layers and their hydration. Two video cameras acquire pictures (Fig.1b): a color camera placed at 15° from the vertical direction records the Newton hues appearing on thin samples ($e < 1\mu m$) and a lateral camera follows the contact angle by recording side views of the water droplet.

We show the impact on wetting of polymer water content, which is set by its water activity. Increasing the latter reduces the contact angle. We compare our measurements with finite element modelling of moisture transfer and with the theory in [3] and show to which extent the “eU” scaling is maintained for thin films. Thick film regime is observed at both high thickness and high contact line velocities.

Complementary wetting experiments where the droplet is pushed in order to reach high values of U are ongoing to better understand the thick film regime. Further complementary experiments in soluble powders are also planned to relate these findings to lump formation during the reconstitution of dehydrated food powders.

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3. A. Tay et al., *How a coating is hydrated ahead of the advancing contact line of a volatile solvent droplet*, (Eur.Phys.J.E, Vol.33, p.203-210, 2010).