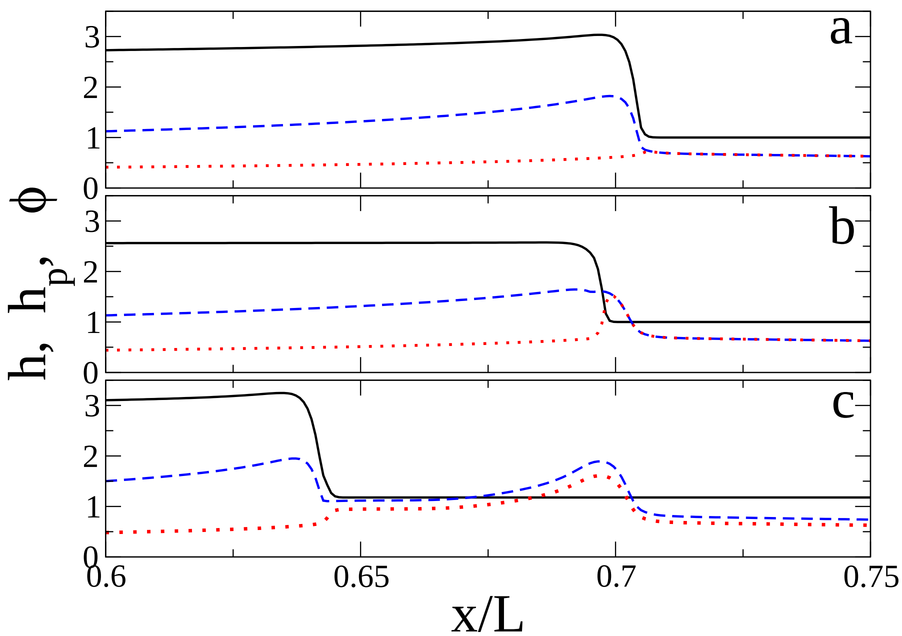

FIG. 7: (Colour online) A sequence of profiles during a dewetting process with competing evaporation and convection that leads to the dried-in ring structure of nanoparticles displayed in Fig. 6(b). Profiles are at (a) before pinning ($t = 0.08T$), (b) at self-pinning ($t = 0.13T$), and (c) after depinning ($t = 0.29T$), where $T = 3 \times 10^{10}\tau$ with $\tau = \eta_0\gamma H/\kappa^2$ (T is of order of 1s). The film thickness profiles h are the bold solid lines, the nanoparticle concentrations ϕ are the dotted lines and the nanoparticle layer height $h_p = h\phi$ are the dashed lines. The remaining parameters and scalings are as in Fig. 6(b).

(i) in Fig. 8). The concentration increases further and when it approaches random close packing ϕ_c, the viscosity diverges and the front pins itself. When pinned, further retraction only occurs through evaporation (Fig. 7(b) and regime (ii) in Fig. 8). The front eventually depins and starts to move again, leaving a nanoparticle ring behind (Fig. 7(c) and regime (iii) in Fig. 8). However, the velocity is not as large as at the beginning, owing to the fact that the mean concentration of particles has increased. The remaining particles are transported to the centre and are deposited there when the remaining solvent evaporates (regime (iv) in Fig. 8).

The simple model used here shows, (i) that the contact line stops due to self-pinning by the deposited particles and (ii) the Marangoni effect is not necessary for the ring formation. The model can easily be refined to account for solutal and/or thermal Marangoni effects [88] but self-pinning