Bubble impact at complex deformable fluid interfaces

Derek Y. C. Chan[1*], Rogerio Manica[2], Evert Klaseboer[2]

[1] *Particulate Fluids Processing Centre, University of Melbourne, Melbourne, Australia*
[2] *A-STAR Institute of High Performance Computing, Singapore*

**D.Chan@unimelb.edu.au*

The rise and impact of bubbles with an initially flat but deformable liquid-air interface is modelled by taking into account the buoyancy force, hydrodynamic drag, inertial added mass effect and drainage of the thin film between the bubble and the interface. The bubble-surface interaction is analyzed using lubrication theory that allows for both bubble and surface deformations under a balance of normal stresses and surface tension as well as the long-ranged nature of the deformation along the interface. Details of the collision and bounce are sensitive to the impact velocity of the rising bubble. This velocity is controlled by the combined effects of interfacial tension via the Young-Laplace equation and boundary condition dependent hydrodynamic stress on the surface that determine the deformation of the bubble. The model can predict the rise velocity and shape of millimeter-size bubbles in ultra-clean water, in two silicone oils of different density and viscosity and in ethanol without any adjustable parameters. The collision and bounce of such bubbles with a flat water/air, silicone oil/air and ethanol/air interface can then be predicted with excellent agreement when compared to experimental observations. More complex interfaces comprised of multilayers can also be modelled [1-3].

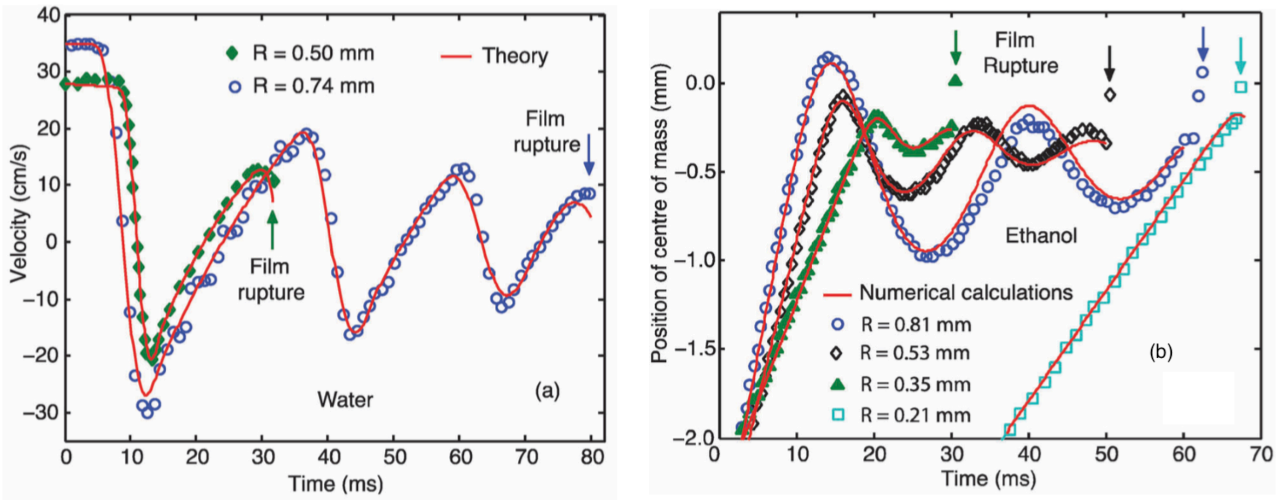

Figure 1 Comparison between model and experiments. **a**) Time variation of the velocity of bubbles of different sizes as they bounce at an air/water interface [4], **b**) Time variation of the position of bubbles of different sizes as they bounce at an ethanol/water interface [5].

Acknowledgements This work is supported by the Australian Research Council Discovery Project Scheme.

[1] R. Manica, E. Klaseboer and D. Y. C. Chan, *Soft Matter*, 2016, **12**, 3271.
[2] R. Manica, E. Klaseboer and D. Y. C. Chan, *Langmuir*, 2015, **31**, 6763.
[3] E. Klaseboer, R. Manica and D. Y. C. Chan, *Phys. Rev. Lett.*, 2015, **113**, 194501.
[4] J. Zawala and K. Malysa, *Langmuir*, 2011, **27**, 2250.
[5] F. Suñol and R. Gonzàlez-Cinca, *Colloids Surf., A*, 2010, **365**, 36.