Nanoparticle deposits formed at driven contact lines

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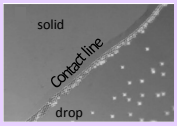
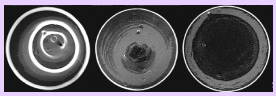
1 Motivation

- **Desiccation of colloidal suspension** drops appears in many applications such as coatings (paints, ink printing, paving), colloidal assembly/templating even biomedicine (diagnostics).
- Ring/stain formation of drying colloidal suspensions is mainly ruled by **contact line dynamics**. Receding contact lines are ubiquitous at evaporating drops but the time scale of the process is extremely long.
- In this work, we measured low-rate dynamic contact angles using a **non-linear variation of drop volume** in order to control the speed of the receding contact line and further to emulate the first stages of drop evaporation at shorter times.

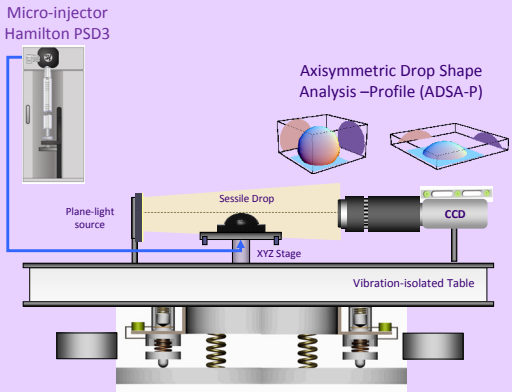




2 Materials and Methods

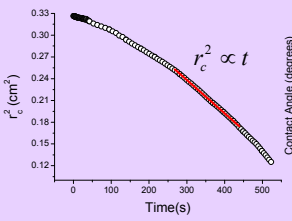
- **Substrate :**
  - PMMA (Goodfellow)
- **Nanoparticles:**
  - Silica 12 nm (Klebosol) and 90 nm (homemade).
  - PMMA 108nm (microParticles GmbH).
- **Solute volume fraction:**
  - 0.5% to 3%
- **Drop volume:**
  - 220µl @ 25ºC RH 50%

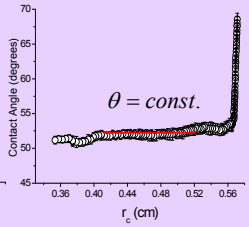
Contact Angle



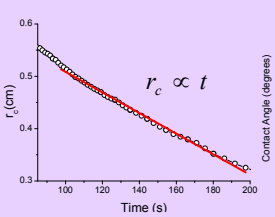
3 Results

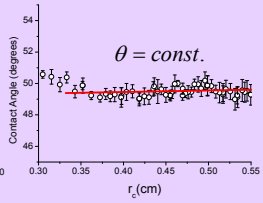
Assisted drop evaporation (distilled water)



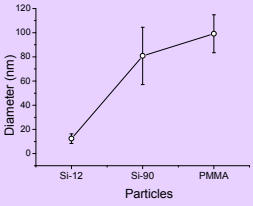


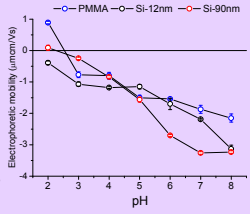
Uniform motion of the contact line (distilled water)



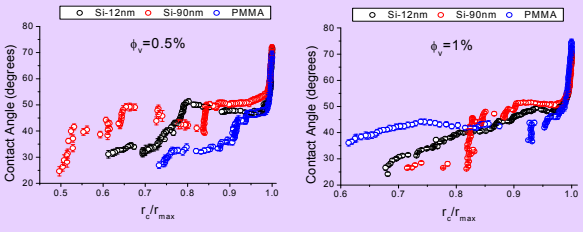


Particle characterization

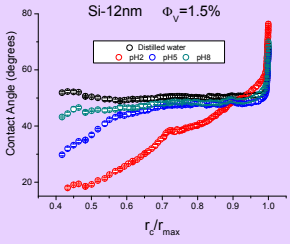




Assisted drop evaporation (nanoparticle drops pH=?)

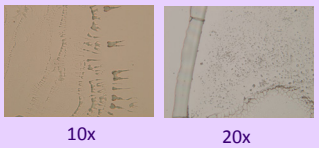


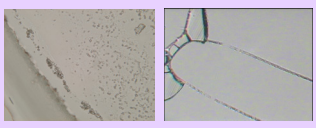
Uniform motion of the contact line (nanoparticle drops pH=?)



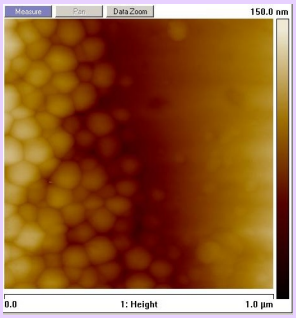
Morphology of the nanoparticle deposits

Optical microscopy





AFM



4 Conclusions

- The first stages of drop evaporation have been emulated at shorter times.
- Stick-slip motion of receding nanoparticle drops is controlled by the interplay between van der Waals and electrostatic forces.
- The morphology of nanoparticle deposits is strongly related with the behaviour of the receding contact line.

5 References

[1] R.D. Deegan, O. Bakajin, T. F. Dupont, G. Huber, S. R. Nagel and T. A. Witten. *Phys Rev E 62, pp* 756-765 (2000).
[2] E. Rio, A. Daerr, F. Lequeux, and L. Limat, *Langmuir 22, pp 3186-3191 (2006).*
[3] H. Yildirim Erbil, G. McHale, S. M. Rowan, and M. I. Newton, *Langmuir, 21, pp 7378-7385 (1999).*
[4] H. Tavana and A.W. Neumann, *Colloids and Surfaces A: Physicochemical and Engineering Aspects, 282-283, pp 256-262 (2006).*

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