How to fill any nanopipettes and to determine their aperture size!

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We describe a dynamic micro-distillation technique that can be used to fill all nanopipettes whatever their shape or aperture size. First, nanopipettes are filled with pure water that is later replaced with the desired electrolyte via electro-migration. Electrical measurements are used to check that filling is complete.

Nanopipette aperture sizes up to 25 nm are determined using a method based on the Poiseuille law. Pressure is applied to the backside of a liquid plug placed in the widest end of the nanopipette, resulting in an air pressure tank with an aperture at the very tip of the nanopipette. Measuring the velocity of the liquid meniscus gives the air flow and thus is related to the aperture size. Aperture size determinations are in good agreement with SEM estimations.

Both methods are simple, efficient, relatively fast and cheap.

[1] B. Tinland, E. Guirleo (Salançon), patent WO 2013079874 A1, “Method and device for filling nanopipettes via dynamic microdistillation”
[2] E. Salançon & B. Tinland, Filling nanopipettes with apertures smaller than 50nm: dynamic micro-distillation submitted to the Beilstein Journal of Nanotechnology (2018).
[3] E. Salançon & B. Tinland, Measuring liquid meniscus velocity to determine size of nanopipette aperture, J. Colloid Interface Sci., **392**, 465–469 (2013)

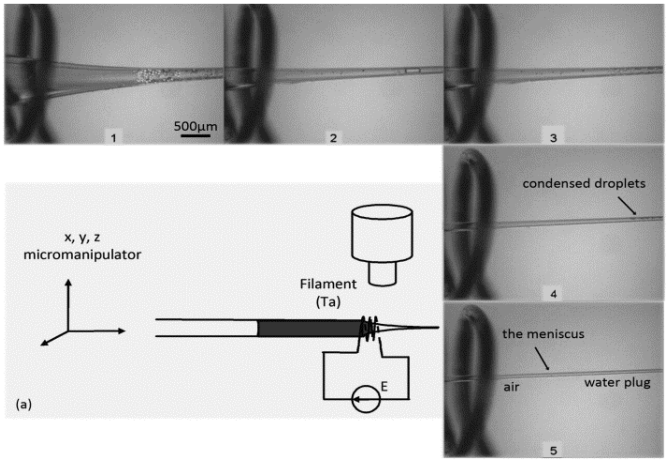

Figure 1 (a) The nanopipette is loaded with water up to its millimeter-to-micrometer region and then inserted into a tantalum loop heated by Joule effect. (1) The heated filament brings the water to boil inside the capillary; water re-condenses further on the cold wall of the nanopipette. (2) The nanopipette is moved to heat the part where the water has re-condensed as droplets. (3) The droplets are boiled again and water is re-condensed further on the next cold part of the nanopipette. (4) The process is repeated. (5) The water is re-condensed at the very end of the tip; the meniscus formed by the water plug and coming from the tip is visible under the optical microscope.