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Droplet Bouncing Effects in Salt Water Electrospray

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The fact that droplets of the same liquid may come into contact without coalescing has been investigated thoroughly in the past, a comprehensive review on the topic is given by e.g. Neitzel & Pasqual (2002). We found that similar phenomena can also be observed in electrospraying, where droplets are ejected from a nozzle under the application of a high electric field (see e.g. the reviews by Grace & Marijnissen (1994) or Shin *et al* 2004).
We report the observation of semi-coalescent bouncing effects of droplets in salt water electrospray while the spray is operating in the micro-dripping mode. In the given examples, the NaCl concentration is 35g/L, the flow rate 5mL/h, and the working distance between nozzle and grounded counter-electrode is 5cm. An example for a semi-coalescent droplet bouncing is given in Fig. 1.

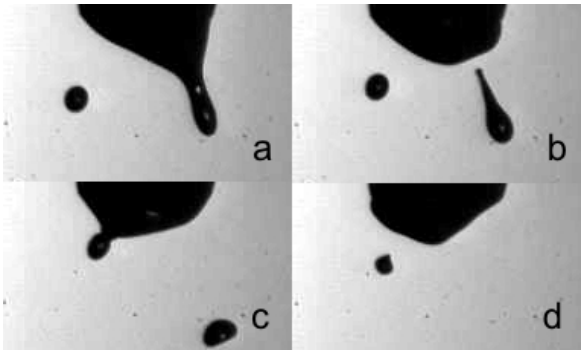

Fig. 1: Semi-coalescent droplet bouncing in salt water electrospray (+12kV). While the right droplet is being ejected from a cone (a,b,c), the previously ejected left droplet returns (a,b), loses mass (c) and is ejected again (d). The images were recorded with 6250 frames/s, the droplet diameter is ~ 100µm.

Three independent effects have to be considered in order to properly describe the phenomenon: The mechanism for the return of the ejected droplet against gravity due to electrokinetic forces, the mass and charge transfer on contact with the liquid surface on the nozzle, and the subsequent re-ejection of the droplet.
Additional, we report the observation of non-tangent bouncing of electrospray droplets. Here, the droplet is repelled by the field without touching the surface of the cone. An example is given in Fig. 2.

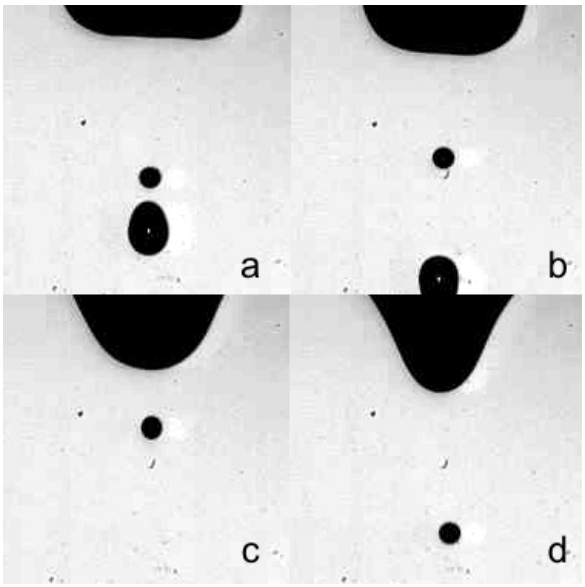

Fig. 2: Non-tangent droplet bouncing in salt water electrospray (-9kV). After two droplets have been formed from a liquid cone (a), one moves away (b) while the other is moving back (b,c) where it finally bounces off the electric field around the growing cone (d). The images were recorded with 5400 frames/s, the droplet diameter is ~ 100µm.
In the case of non-tangent droplet bouncing as shown in Fig. 2, it is assumed that the smaller droplet is first repelled by the bigger one below pushing it back upwards to the cone which finally repels it again. This is plausible because both droplets and cone are negatively charged. However, since the non-tangent bouncing has also been observed without a second droplet, attractive electric forces have to be considered as well.

Based on the works of Hartman *et al* (1999), the principles of non-coalescence and EHD, a possible explanation of the observed effects will be proposed.

G. P. Neitzel & P. Dell'Aversana (2002), *Annu. Rev. Fluid. Mech.* **34** 267-89
J.M. Grace & J.C.M. Marijnissen (1994), *J. Aerosol Sci*. **25**. No. 6, 1005-1019
W.-T. Shin, S. Yiacoumi, C. Tsouris (2004), *Cur. Op. Coll. & Interf. Sc*. **9,** 249-255
R.P.A. Hartman, D.J. Brunner, D.M.A. Camelot, J.C.M. Marijnissen & B. Scarlett (1999), *J. Aerosol Sci.* **30** No. 7, 823-849