Electrohydrodynamic spraying from extractor-free one-dimensional arrays

N. Sochorakis[1], J. Grifoll[1] and J. Rosell-Llompart[1,2]

[1]Chemical Engineering Department, Universitat Rovira i Virgili, Tarragona, E-43007, Spain
[2]ICREA – the Catalan Institution for Research and Advanced Studies, Barcelona, E-08010, Spain
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Presenting author email: nikolas.sochorakis@urv.cat

Electrospray is a liquid atomization process capable of producing monodisperse microdroplets. Simultaneous operation of many electrospray emitters (multiplexing) is required to achieve industrially relevant production rates. The linear array of electrospray emitters is a geometry of interest for producing coatings and particles. However, the electrical field at any one given emitter is weakened by the electrostatic charges from the sprays and the other emitters. Therefore, this work aims to identify robust configurations that lead to stable spraying from linear arrays.

We have characterized the conditions leading to stable cone-jet mode and spray plume behaviour in linear arrays as a function of the geometrical parameters of the arrays and the relevant liquid properties (e.g. electrical conductivity). We have established:

(1) that it is possible to produce stable spraying along the linear array without the aid of extractor-type electrodes (otherwise necessary in 2D arrays; Bocanegra et al, 2005; Deng et al, 2006), provided that "blind emitter" electrodes are located at the ends of the array (in agreement with Rulison and Flagan, 1993, Hubacz and Marijnissen, 2003, and Quang Tran *et al*, 2010) (Fig. 1a-1c);

(2) that the sprays are similar for all emitters except those at the ends (Fig. 1a), where the spray is more expanded and their deposition patterns are oval ("kidney"-like) instead of elliptic, as found elsewhere (Fig. 1d);

(3) that the electrical potential difference needed to sustain stable operation increases with the number of spraying emitters but tends towards an asymptotic value (i.e., it is bounded regardless of the length of the array);

(4) that as the pitch (inter-emitter separation) is reduced below the spray width at the collector, the spray elongates along the array-cross direction, and distorts in correlation with the sprayer misalignments (Fig. 1d);

(5) and that at high electric field strength (Fig. 1b), the Taylor cones retract, becoming misaligned and producing distorted spray patterns, similarly as for single emitter electrosprays.

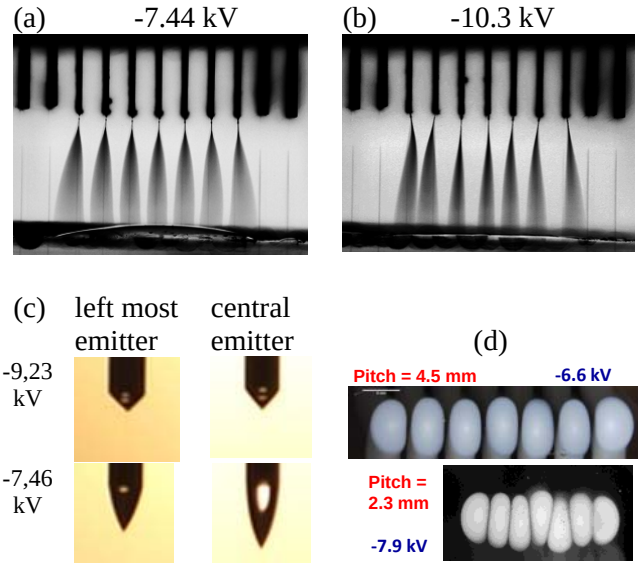

Figure 1. (a),(b): Spray plumes from seven emitters operating in cone-jet mode (94:4:2 ethylene glycol/AcH/water with 0.00038 S/m; negative image). (c): Taylor cones response to voltage is nearly the same for different emitters. (d): Deposition patterns from two arrays with different inter-emitter distance (pitch) (1% w/v ethyl cellulose in 2-butanone). All: The reported minus voltage is applied to collection plate; emitters and top plate are Earth-grounded.

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