From Electro-Hydro-Dynamics of liquids for the production of charged droplets by Electro-Spray to applications for tailored Materials (aerosols, powders, coatings) and Environment

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1. Volume title and order of guest editors (names, titles, affiliations and contact information).

*" From EHD of liquids to Production of droplets by Electro-Spray
to applications for tailored materials (aerosol, powders, coatings) and environment".*

Guest editor: Dr, Jean-Pascal BORRA,
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2. List of papers (titles, author) = table of content of the special Issue with **10 papers, including 7 reviews**

Introduction - "Scope of the special Issue", by Borra JP, CNRS, France =Non manuscript

1) FUNDAMENTALS

- 1.1- Electrosprays In the cone-jet mode: from Taylor cone formation to spray development (Review by J. Rosell-Llompart, J. Grifoll and I. Loscertales*, Spain)
- 1.2- Review on the physics of electrospray: from electrokinetics to the operating conditions of single and coaxial Taylor cone-jets, and AC electrospray (Review by A.M. Gañán-Calvo, J.M. López-Herrera, M.Herrada, A. Ramos, J.M. Montanero, Spain)

2) ES APPLICATIONS for MATERIAL PRODUCTION (AEROSOL / POWDERS / COATINGS)

2.1- ES as a production process of powders and coatings (2 papers)

- 2.2.1- Electrospray application to powder production and surface coating (Review by A. Jaworek, Sobczyk A.T., Krupa A., Poland)
- 2.2.2- Polymer solution electrospraying: A tool for engineering particles and films with controlled morphology (E. Bodnár, J. Grifoll and J. Rosell-Llompart Spain)

2.3- ES for Energy applications

- 2.3.1- EDHA for Energy Production, Storage and Conversion Devices, (Review by E. Kelder and JC Marijnissen, Netherlands)
- 2.3.2- Nanostructured porous coatings via ES Deposition of suspensions (J.L. Castillo, S. Martin, D. Rodriguez-Perez, F. Higuera, P.L. Garcia-Ybarra, Spain)

2.4- ES for biomedical and biotech applications

- 2.4.1- Electrospraying an enabling technology for pharmaceutical and biomedical applications: A review (Review by S. K Boda., X. Li and J. Xie, USA)
- 2.4.2- Electrospray deposition of biomolecules: applications, challenges, and recommendations (Review by S. Kavadiya and P. Biswas, USA)
- ~~2.4.3- Nano ES DMA for the characterization of proteinaceous nanoparticles—from small peptides to intact viruses (Review by V. U. Weiss and G. Allmaier, TU Wien, Austria)~~

3) WATER ES FOR ENVIRONMENTAL APPLICATIONS

- 3.1- Review on Water Electro-Sprays and applications of charged droplets with focus on the corona-assisted cone jet mode for High Efficiency Particles Air Filtration by wet electro-scrubbing of aerosols (Review by JP Borra, France)
- 3.2- Simple-jet mode electrosprays with water. Description, characterization and application in a single effect evaporation chamber (Agostinho L.L.F., Marijnissen J.C.M., Kamau A. and Bernard Bos B., Netherlands)

3. EDITORIAL

On the last decades, there have been considerable break-through on ***Electro-Spray as a simple, compact and flexible process to achieve the continuous production of charged droplets from any liquid (ES)***.

First used for painting with multi-ES rotative cup or crop spraying, where the droplet size was not considered as critical, more than 3000 publications support the interest in this process since the 1990's. Most deals with two applications; for bio-molecules analysis, where electro-spray is used as an ion source for mass spectrometry awarded by Fenn's Nobel prize. Then, to produce polymer fibers by "Electro-Spinning" for filters, fabrics and more generally for membranes with large specific areas for enhanced interfacial processes. Both are well documented and are thus not covered here. Readers can refer to following key words for low pressure processes (ESIonisation, ES thrusters for satellite repositioning, metal droplets and molecular layer deposition for coatings) and for atmospheric pressure electro-spinning.

This special issue aims to trigger scientists and process engineers' interest for "***electro-spray, as a tunable source of monodisperse charged droplets in processes for Materials and Environment, with current developments and challenging perspectives***".

The initial theoretical overview of Electro-Hydro Dynamics deformation and fragmentation of liquids into droplets accounts for the different spraying modes. A particular attention is paid to the most suitable cone-jet mode with respect to finely tuned droplet sizes (nm-mm) defined by scaling laws up to spray development, versus liquid properties and operating parameters -liquid flowrate and voltage, gas pressure and nozzle geometry-. This includes the quasi-stationary EHD equilibrium defining the cone and jet shapes and operating conditions as well as electro-kinetic models to account for co-axial ES, mainly used for the production of high-added value core-shell composite particles, with applications in the following part.

Important practical applications of self-dispersed charged sprays from electro-spray in cone jet mode are presented with reviews on process principles and devices for the production of tailored materials (aerosol, powder and coating). Here, the particular case of polymer ES is addressed. Then, continuous atmospheric pressure ES Deposition of different coatings from homogeneous pinhole free to nano-composite coatings using ES of suspensions are presented for energy production, conversion and storage in fuel and photovoltaic cells, low cost LED and OLED,... Then, Bio-applications of ES are depicted for the processing of functional coatings required for cell targeting, imaging, and drug delivery with core-shell particles as well as of structural coating for implants and sensors, including preparation of bio-suspensions and emulsions by ES.

The last part focusses on water electro-spray for environmental applications to air and water treatments. Aerosol filtration from exhaust fumes and smokes is depicted in a particular steady corona-assisted cone-jet mode of water electro-spray. At last, potential applications of ES for water desalination and metal recovery are addressed.