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www.elsevier.com/locate/jaerosci

PII: S0021-8502(17)30432-9
DOI: https://doi.org/10.1016/j.jaerosci.2018.04.011
Reference: AS5279

To appear in: *Journal of Aerosol Science*

Received date: 31 October 2017
Revised date: 30 April 2018
Accepted date: 30 April 2018

Cite this article as: E.M. Kelder, J.C.M. Marijnissen and S. Waiyego Karuga, EDHA for Energy Production, Storage and Conversion Devices, *Journal of Aerosol Science,* https://doi.org/10.1016/j.jaerosci.2018.04.011

EDHA for Energy Production, Storage and Conversion Devices

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Abstract

Electrohydrodynamic atomization (EHDA) or electrospraying stands out in thin film deposition because of its unique ability to form charged droplets, initiating higher deposition efficiencies in electrostatic spray deposition. Considering that the quality of a thin film depends on the particle sizes, their monodispersity and uniform distribution on the surface, electrospray is a powerful tool in materials synthesis. Therefore, this review looks at different areas where this novel technique has been used to improve on the overall performance of materials for energy devices, such as solar cells, photoelectrochemical cells, rechargeable batteries and beyond, capacitors, and (O)LEDs, including quantum dots.

List of abbreviations used

AlN, Aluminium Nitride; AN, Acetonitrile; CB, Chlorobenzene; CIGS, Cu-In-Ga-Se; CIGSSe, $Cu(InGa)(SSe)_2$; CIS, Copper Indium Sulfides/Selenides; CNT, Carbon Nanotube; CN-PPV, poly[2,5-di(hexyloxy)cyanoterephthalylidene]; CV, Cyclic Voltammetry; CZTS, Copper-Zinc-Tin-Sulfide; CZTSe, Copper-Zinc-Tin-Selenide; CZTSSe, Copper-Zinc-Tin-Sulfide/selenide; DCB, Dihlorobenzene; DCE, 1,2-dichloroethane; EC, Electrochemical Capacitor; EHDA, ElectroHydroDynamic Atomization (EHDA; EL, ElectroLuminescence; EML, Emissive Layer; ESAVD, ElectroSpray Assisted Vapour Deposition; ESD, Electrostatic Spray Deposition; FF, Fill Factor; FTO, Fluorinated Tin Oxide; GNP, Graphene Nano-Platelet; GO, Graphene Oxide; IR, InfraRed; $Ir(mppy)_3$, tris(2-(4-tolyl)phenylpyridine)iridium; ITO, Indium Tin Oxide; LED, Light Emitting Diode; LIB, Lithium Ion Battery; Li-S, Lithium Sulfur; MEH-PPV, poly[2-methoxy-5-(2ethylhexyloxy)-1,4-phenylenevinylene; MPBL, Multifunctional Polysulfide Blocking Layer; MWNT, Multi-Walled Carbon Tube; NPCS-S, Hybrid Sulfur and Nitrogen-Doped Porous Carbon Sheet (NPCS); NVP, Sodium Vanadium Phosphate ($Na_3V_2(PO_4)_3$; OLED, Organic Light Emitting Diode; OPV, Organics PhotoVoltaics; OTFT, Organic Thin Flm Transistors; PAN, Polyacrylnitrile; PBD, 2-(4-biphenylyl)-5-(4-tert-butylphenyl)-1,3,4-oxadiazole; PCE, Power Connversion Efficiency; PCNF, Porous Carbon-NanoFiber; PEC, PhotoElectrochemical Cell; (PE)CVD, Plasma-Enhanced Chemical Vapour Deposition; PEDOT:PSS, poly(3,4-ethylenedioxythiophene): polystyrene sulfonate; PLED, Polymer Light-Emitting Diode; PSC, Perovskite Based Solar Cells; PVK, Poly(N-vinyl carbazole; rGO, reduced Graphene Oxide; RHE, Reversible Hydrogen Electrode; SEM, Scanning Electrochemical Microscopy; TCO, Transparent Conductive Oxide; TPD, N,N'diphenyl-N,N'-bis(3-methylphenyl)-[1,1-biphenyl]-4,4'-diamine; QD, Quantum Dot; XRD, X-Ray Diffraction

Keywords: EHDA; Electrospraying; ESD; Li-ion batteries, Solar cells

1 Introduction

Electrohydrodynamic atomization (EHDA) or electrospraying stands out in thin film deposition because of its unique ability to form charged droplets hence higher deposition efficiency, i.e. electrostatic spray deposition (ESD), which term will be used further throughout this chapter. It involves disintegration of a liquid into airborne droplets by applying an electric field which causes shear stress on the liquid surface leading to elongation of a jet that breaks up into small charged droplets. Due to the mutual Coulomb repulsion among the droplets, there is self-dispersion on the substrate hence no agglomeration resulting in uniform deposition on inhomogeneous surfaces (Lee et al., 2007; Yoon et al., 2003; Cao et al., 2002; Nishizawa et al., 1998; Chen et al., 1995; van Zomeren, 1994). For instance, with an aim of synthesizing Co_3O_4