UAEU جامعة الإمارات العربية المتحدة United Arab Emirates University

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Master Thesis Defense

Entitled

ADVANCED NANOSTRUCTURED MATERIALS FOR WATER HARVESTING AND ENERGY STORAGE

By

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Abstract**:**

This thesis presents the work done developing nanotechnology-based compositions contributing to the advancement of two main sectors; Water and Energy. For they present vital impact and correspondence for sustainability and development worldwide. Composites constituted following the most recent trends in material science and nanotechnology while revolving around Manganese Oxide as the material of investigation. Water security is one of the most important challenges in our current times. Moreover, reports warn of the predicted restricted access to clean water by 2050, which is expected to impact more than half the population. Thus, many scientists and societies are exerting efforts to develop a sustainable and feasible solution. Modules of atmospheric water harvesting-based technology are sought as a promising answer. The attractiveness lies in the feasibility and low cost through a variety of materials. In our work, we aim to boost the collection of aluminum-based mesh. As natural creatures inspire us, adopting flowerlike sempervivum plants and constructing an architecture surface of alternating hydrophilic-hydrophobic chemistry referencing desert beetles (Stenocara gracilipes). Our composition illustrates a flowerlike morphology from nanostructured manganese oxide, tunable through a polymer linker; Polyacrylonitrile. Controlling the surface properties, our composed NF-MnO_2 / PAN nanostructure paradigm advances the droplets to drop growth and release process and collecting efficiently an estimate of 45 L/m^2 per Hour. In the second part of this thesis, paving for a composition facilitating the rise in energy demand. Our extended efforts investigated materials applicable to supercapacitors (SC) type of energy storage devices. Supercapacitor's attractive fundamentals value high energy and power factors. Our hybrid SC joins the efficient electric double-layer capacitor's (EDLC) fast charge and discharge of electrons and ions, on an increased surface area, with the pseudo-capacitance faradic current attributed to the redox reactions corresponding to the metal oxides composed. A composite material has been investigated, developed, and improved to bridge the gap between theoretical values and experimental outcomes by the insertion of carbon-based materials for better conductivity, supported by carbon nanotubes to modify their properties, increasing the stability with polymeric binders for easier proton transport and ionic migration. In our paradigm, a variety of manganese oxides with different morphologies and phases/ structures have been investigated for hybrid nanostructures with modified properties. Our resultant composite had successfully exerted very high specific capacitance in a cell of high eco-chemical stability with electrochemical capacitive retention where the specific capacitance of the composite reached 1456 F/g at 2mV/s in cyclic voltammetry measurement and had a high retention profile above 95% after 11000 cycles during GCD at 1 A/g in an environmentally eco-friendly cell system suitable for industrial scale-up.

Keywords: Manganese Oxide, Fog harvesting, Nanostructures, Energy storage, Supercapacitors, Energy density.