Industrial Waste to Energy Technology: Engineering Biowaste as High Potential Anode Electrode for Application in Lithium-Ion Batteries

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Abstract : Increasing the growth of industrial waste due to the large quantities of production leads to numerous environmental and economic challenges, such as climate change, soil and water contamination, human disease, etc. Energy recovery of waste can be applied to produce heat or electricity. This strategy allows for the reduction of energy produced using coal or other fuels and directly reduces greenhouse gas emissions. Among different factories, leather manufacturing plays a very important role in the whole world from the socio-economic point of view. The leather industry plays a very important role in our society from a socio-economic point of view. Even though the leather industry uses a by-product from the meat industry as raw material, it is considered as an activity demanding integrated prevention and control of pollution. Along the entire process from raw skins/hides to finished leather, a huge amount of solid and water waste is generated. Solid wastes include fleshings, raw trimmings, shavings, buffing dust, etc. One of the most abundant solid wastes generated throughout leather tanning is shaving waste. Leather shaving is a mechanical process that aims at reducing the tanned skin to a specific thickness before tanning and finishing. This product consists mainly of collagen and tanning agent. At present, most of the world's leather processing is chrome-tanned based. Consequently, large amounts of chromium-containing shaving wastes need to be treated. The major concern about the management of this kind of solid waste is ascribed to chrome content, which makes the conventional disposal methods, such as landfilling and incineration, not practicable. Therefore, many efforts have been developed in recent decades to promote eco-friendly/alternative leather production and more effective waste management. Herein, shaving waste resulting from metal-free tanning technology is proposed as low-cost precursors for the preparation of carbon material as anodes for lithium-ion batteries (LIBs). In line with the philosophy of a reduced environmental impact, for preparing fully sustainable and environmentally friendly LIBs anodes, deionized water and carboxymethyl cellulose (CMC) have been used as alternatives to toxic/teratogen N-methyl-2- pyrrolidone (NMP) and to biologically hazardous Polyvinylidene fluoride (PVdF), respectively. Furthermore, going towards the reduced cost, we employed water solvent and fluoride-free bio-derived CMC binder (as an alternative to NMP and PVdF, respectively) together with $LiFePO_4$ (LFP) when a full cell was considered. These actions make closer to the 2030 goal of having green LIBs at 100 $ kW h^{-1}. Besides, the preparation of the water-based electrodes does not need a controlled environment and due to the higher vapour pressure of water in comparison with NMP, the water-based electrode drying is much faster. This aspect determines an important consequence, namely a reduced energy consumption for the electrode preparation. The electrode derived from leather waste demonstrated a discharge capacity of 735 mAh g^{-1} after 1000 charge and discharge cycles at 0.5 A g^{-1}. This promising performance is ascribed to the synergistic effect of defects, interlayer spacing, heteroatoms-doped (N, O, and S), high specific surface area, and hierarchical micro/mesopore structure of the biochar. Interestingly, these features of activated biochars derived from the leather industry open the way for possible applications in other EESDs as well.

Keywords : biowaste, lithium-ion batteries, physical activation, waste management, leather industry
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