Crucial Parameters to Obtain a High-Performance Supercapacitor from Plastic Waste

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Activated carbons (ACs) find common use in electric double layer capacitance (EDLC) supercapacitors. One sustainable approach to produce ACs involves repurposing plastics as a raw material, effectively addressing plastic waste management.
In our research, we introduce a two-step procedure comprising pyrolysis followed by chemical activation. This method successfully converts conventional plastic waste into activated carbons suitable for use as electrode materials in supercapacitors (Figure 1). In addition to established parameters like specific surface area and micropore volume, our study underscores the significance of several crucial factors, including the polymer's glass transition temperature, compatibility between the polymer and activating agent, the ratio of the activating agent (K_2CO_3) to ACs, and the stability of ACs when dispersed in water. By fine-tuning these parameters, we achieved ACs with competitive electrochemical performance metrics. Specifically, the ACs exhibited a specific capacitance of 220 F g^{-1} (at a current density of 1 A g^{-1}), energy and power densities of 61.1 Wh kg^{-1} and 36.9 kW kg^{-1}, respectively, along with outstanding cycling stability (95% retention after 30,000 cycles).
Incorporating recycled plastic into the production of supercapacitors has the potential to reduce manufacturing expenses when compared to traditional feedstocks for active carbon. This, in turn, can promote enhanced resource efficiency and a more sustainable approach to the manufacture of supercapacitors. Our findings pave the way for transforming plastic waste into valuable electrode materials for supercapacitors.

Figure 1: The process sequence, starting from polymer waste, through the creation of activated carbons (ACs), and ultimately leading to the assembly of a supercapacitor device.