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Carbonized Chicken Eggshell Membranes with 3D Architectures as Flexible High-Performance Electrode Materials for Supercapacitors

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We synthesized flexible supercapacitor electrode materials by carbonizing a common livestock biowaste in the form of chicken eggshell membranes. The carbonized eggshell membrane (CESM) is a three-dimensional macroporous carbon film, composed of interwoven connected carbon fibers containing around 10 wt% oxygen and 8 wt% nitrogen. The macroscopic structure of the CESM resembles that of construction paper. Despite relatively low surface area of 221 $m^2 g^{-1}$, exceptional specific capacitances of 297 F g^{-1} and 284 F g^{-1} are achieved in basic and acidic electrolytes in 3-electrode system, respectively. This yields an unusually high volumetric energy density in the range of 600 F cm^{-3}. Furthermore the electrodes demonstrate excellent cycling stability: only 3% capacitance fading is observed after 10,000 cycles at a current density of 4 A g^{-1}. These very attractive electrochemical properties are discussed in the context of the unique structure and chemistry of the material.