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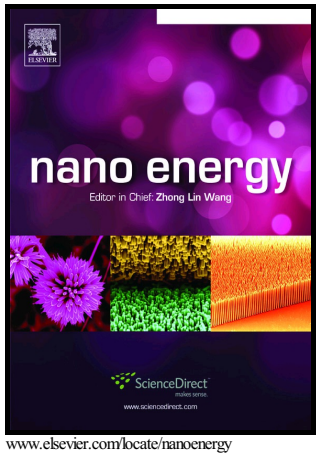

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Scalable Fabrication of Flexible Thin-Film Batteries for Smart Lens Applications

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Abstract

The smart lens system is considered one of the ultimate wearable electronics platform, with potential applications in visual-guide or health-monitoring system. However, its development has so far been limited by the development of suitable flexible batteries. Conventional flexible battery fabrication relies on laser-based lift-off techniques, which greatly hinder scalability of such batteries. Here, we design and demonstrate the flexible thin film batteries applied to contact lens form-factor, with direct fabrication on polymer substrates and single step low-temperature annealing. The battery utilizes olivine $LiFePO_4$ thin film cathode, fabricated with 90° off-axis sputter deposition. This achieves unique nanoscale microstructure required for electrochemically active $LiFePO_4$ thin films and effectively reduces the annealing temperature of $LiFePO_4$ down to 400°C for the first time. Equipped with lithium phosphorous oxynitride (LiPON) solid electrolyte and lithium metal anodes on polyimide substrates, the battery demonstrates the energy storage capacity of 35 μWh under wet condition. The storage capacity is sufficient to power glucose sensors embedded on the smart lens for up to 11.7 hours. In addition, the high energy density of 70 $\mu Wh/cm^2$ flexible batteries may enable a diverse set of micro-scale devices, with scalable and CMOS-compatible fabrication processes.