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Directly fabricated flexible thin film batteries on polymer substrate

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The advanced wearable electronics such as bio-sensors and chemical-sensors require flexible and lightweight lithium batteries with a great cyclability and high energy density. All-solid-state lithium batteries have received attention in these years because of their safe characteristic and high density. Also, using a polymer substrate for electronics is the current trend due to its disposable, lightweight, and bendable properties. However, the major problem to investigate flexible batteries on the polymer substrate is a crystallization of the cathode thin film at high temperature. Eventually, the polymer substrate decomposed, so a new direction of crystallization should be considered. Here, we present a new fabricating method for all-solid-state $LiNi_{0.5}Mn_{1.5}O_4$/LiPON/Li structure flexible lithium batteries using excimer laser annealing system. Excimer laser annealing can selectively crystallize $LiNi_{0.5}Mn_{1.5}O_4$ cathode thin film in low temperature without thermal damage of substrate. The excimer laser annealed cathode thin films were well crystallized without damage and it could be easily applied large-area by scanning laser. Structural properties of the thin films were investigated by X-ray diffraction (XRD), transmission electron microscope (TEM), and scanning electron microscopy (SEM). The initial capacity of flexible battery on polyimide substrate was 20μAh μm-1 cm-2 at 0.2 C-rate with operating voltage of 4.6 V. Therefore, we expect that these batteries make it possible to be applied as a power source for various types of micro-sensors.

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Near-infrared optogenetics: A novel design for controlling the electric activity of targeted cells with upconverting nanoparticles

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Optogenetics is an innovative technology now widely adopted by researchers in different fields of the biological sciences. However, due to the weak tissue penetration capability of the short wavelengths used to activate light-sensitive proteins, an invasive light guide has been used in animal studies for photo-excitation of target tissues. Upconverting nanoparticles (UCNPs), which transform near-infrared (NIR) light to short-wavelength emissions, can help address this issue. To improve optogenetic performance, we enhance the target selectivity for optogenetic controls by specifically conjugating the UCNPs with light-sensitive proteins at a molecular level, which shortens the distance as well as enhances the efficiency of energy transfer. We tagged V5 and Lumio epitopes to the extracellular N-terminal of channelrhodopsin-2 with an mCherry conjugated at the intracellular C-terminal (VL-ChR2m) and then bound NeutrAvidin-functionalized UCNPs (NAv-UCNPs) to the VL-ChR2m via a biotinylated antibody against V5 (bV5-Ab). We observed an apparent energy transfer from the excited UCNP (donor) to the bound VL-ChR2m (receptor) by measuring emission-intensity changes at the donor-receptor complex. The successful patch-clamp electrophysiological test and an intracellular Ca2+ elevation observed in the designed UCNP-ChR2 system under optogenetic manipulation confirmed the practical employment of UCNP-assisted NIR-optogenetic functionality. This work represents a significant step toward improving therapeutic optogenetics.

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