University of Florida

Integrated PV/Storage and PV/Storage/Lighting Systems

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Description: The goal is to increase the efficiency and reduce the cost of solar power through the integration of PV, Li-battery, and LED lighting technologies. Since all components are in the form of thin films, the PV/battery/LED system can be integrated as a single module. Since half of the materials cost of each device is the substrate, integrated module will also reduce materials costs and processing steps. Importantly, their integration further eliminates the need for inverters since they are all low-voltage devices. Such an integrated device can be used to store energy during the day and power the LED panel for lighting in the evening. In addition, we will explore the possibility of fabricating a semi-transparent module. The success of this Task will lead to a novel solar-power lighting panel that can be used as a sky light during the day and a lighting panel during the night without using grid-power. We not only will develop the technologies, but also integrate devices and perform technology-economic evaluation, including life-cycle costs.

Budget: $576,000

Universities: UF

Progress Summary

Research Objectives for Current Reporting Period: The main research objectives for the current reporting period include have optimize the synthesis process, understand the critical role on stoichiometries of the precursors on the electrochemical properties of the proposed lithium excess manganese nickel oxide materials, and investigate the change of crystal structure during electrochemical processes and its impact on cycling stability of the high energy lithium ion cells.

Progress Made Toward Objectives During Reporting Period:
In the area of lithium ion cells, we focus on studying the effect of synthesis conditions on the electrochemical properties of $Li[Ni_xLi_{1/3-2x/3}Mn_{2/3-x/3}]O_2$. During the co-precipitation, an excess amount of $LiOH{\cdot}H_2O$ solution was used to ensure complete precipitation of the transition metal double hydroxide. Intentional surface modifications of $xLi_2MnO_3{\cdot}(1-x)LiMO_2$ (M=Mn, Ni and/or Co) can significantly improve the electrochemical performance compared to bare-surface materials. The stoichiometric materials had well defined clean crystalline surfaces as shown in Figure 1a, while the LiOH excess materials showed different surface characteristics from the bulk, see Figure 1b. We also found that the electrochemical performance of the material sintered at 1000°C shows consistently better reversible capacity compared to that synthesized at 900°C.

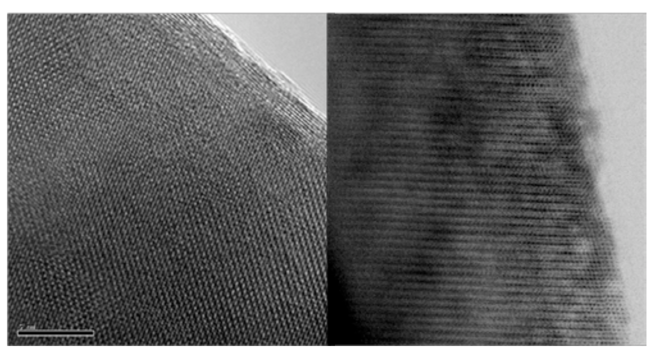

Figure 3. TEM images of a) stoichiometric b) LiOH excess $Li[Ni_{1/5}Li_{1/5}Mn_{3/5}]O_2$ synthesized at 1000°C with furnace cooling.

In the PV area, we have been studying the effect of anode interlayer on the device performance. In our previous report, we used MoO_3 as an anode interlayer to enhance charge extraction. We have recently found that the device performance can further be enhanced by inserting an electron blocker at the anode interface in addition to the MoO_3 interlayer. For MDMO-PPV cells, a 50% enhancement in power conversion efficiency was observed.

In the OLED area, we have been working on enhancing the light outcoupling efficiency in OLEDs by attaching a microlens array to the light-emitting surface of the glass substrate. The nearly close-packed hemispherical microlens array was made out of an optical adhesive using a molding process (with a concave mold of PDMS). Arrays up to 4" wafer size can be easily made. Figure 2 shows the optical microscope image of 100 μm diameter microlenses over a few mm size. The inset shows the cross-section image of a microlens under scanning electron microscope. Applying such a microlens array to an OLED leads to an enhancement of 50-70% of the overall efficiency of the OLED.

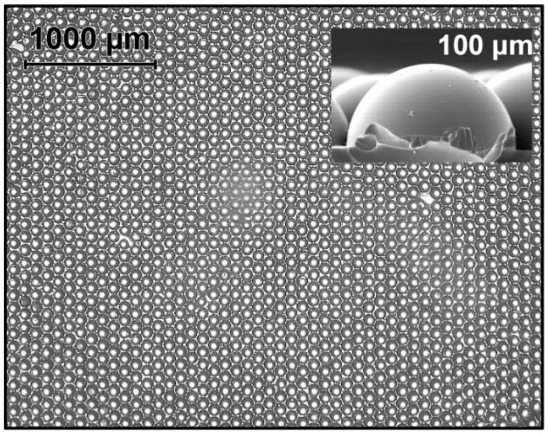

Figure 4. Optical micrograph of microlenses fabricated. The inset shows the cross-sectional SEM image.