$LiCoO_2$ thin film trench cathodes deposited by liquid-delivery metalorganic chemical vapor deposition for rechargeable lithium batteries

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The fabrication of lithiated intercalation oxides in thin film form is of great interest as a result of their possible use as positive electrode in all-solid-state lithium rechargeable microbatteries to power microelectronics.

In many lithiated intercalation oxides, $LiCoO_2$ is most widely used as the cathode material for both Li rechargeable batteries and thin-film microbatteries due to its advantages including high specific capacity, high operating voltage, long cycle life and ease of manufacture.

Recently, cathode electrode films are usually prepared by electron beam evaporation, pulsed-laser ablation[1], sputtering, sol-gel method, and chemical vapor deposition[2-3]. Although there are various reports of physical vapor deposition techniques, there were particular advantages to use a chemical vapor process to deposit thin films of these lithiated transition metal oxides. Chemical vapor deposition (CVD) technique can easily prepare the desired high temperature crystalline phases of $LiCoO_2$ at temperatures as low as 300 ℃ and offer advantages such as excellent control of stoichiometry, easy control of crystallinity, density, and microstructure. CVD also offers a good step-coverage in trench structure and then can increase the cathode area per unit volume, as compared with planer deposition by physical vapor deposition techniques. The increase of cathode area by deposition in trench structure using CVD can enhance the discharge capacity of $LiCoO_2$ cathodes. However, the systematic study for electrochemical properties of $LiCoO_2$ thin film cathodes prepared by CVD has not been reported elsewhere.

$LiCoO_2$ thin film cathodes were successfully deposited onto planar and trench Pt substrates by liquid-delivery metalorganic chemical vapor deposition as shown in Fig. 1. The step-coverage of Pt and $LiCoO_2$ films was about 56 and 51 %, respectively. The step-coverage of these films should be improved for rechargeability of $LiCoO_2$ cathodes. Figure 2 shows the initial discharge curves for $LiCoO_2$ thin films deposited on planar and trench structure of Pt collector with various Li/Co input mole ratios at 450°C. The Li/Co input mole ratios were varied from 0.4 to 1.0. The discharge capacity slightly increased with Li/Co input mole ratio up to 0.7 and then decreased above 0.7. The discharge capacity shows clear dependence on Li/Co ratio. The initial discharge capacity of trench-$LiCoO_2$ cathodes was greatly improved as compared with planar structure. In this study, trench $LiCoO_2$/Pt structures will be studied for improvement of cyclic properties as well as that of initial discharge capacity.

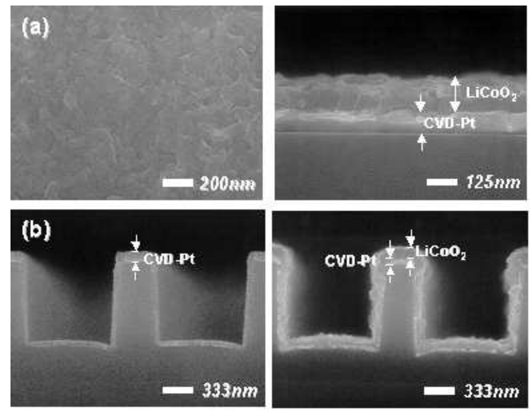

Fig. 1. SEM images of (a) planar structure of $LiCoO_2/Pt/Ti/SiO_2/Si$ and (b) trench structure of $Pt/SiO_2/Si$ and $LiCoO_2/Pt/SiO_2/Si$ deposited at 450□

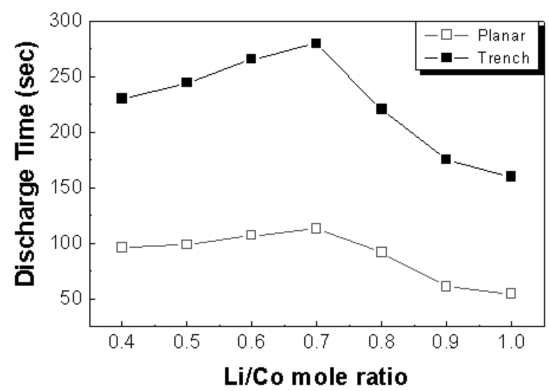

Fig. 2. Initial discharge capacities for $LiCoO_2$ thin films deposied on planar and trench structure of Pt collector with various Li/Co input mole ratios at 450℃.

References

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