The electrochemical characteristics of a-Si thin film anodes prepared by low pressure chemical vapor deposition for Li secondary batteries

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Recently, much research has been performed on the thin film rechargeable microbatteries since Kanehori and co-workers reported the fabrication of such battery composed of TiS_2 cathode and lithium anode and phosphosilicate electrolyte.

Li metal is the most favorable anode material in the aspects of electrode potential and specific energies. But, Li metal is very reactive and should be handled in moisture-free environments. And, dendritic Li growth as the metal was replated during each subsequent discharge-recharge cycle has evoked research for substitutive anode materials. Thus, various alternative materials such as lithium alloys and metal oxides have been extensively studied. Carbons are also used for negative electrodes because lithium can reversibly inserted into them. However, carbon anodes have irreversible capacity loss (ICL) in the first cycle and require high temperature annealing.

Some anode materials have large charge capacity but cyclic durability is still unsatisfactory. In this study, electrochemical performance of amorphous silicon electrode was examined. Cyclic durability was greatly enhanced by controlling lower voltage limit or by reducing the amount of cycled charge quantity. The thin-film silicon anode was also coupled with thin-film $LiMn_2O_4$ cathodes in $LiClO_4$ based liquid electrolyte to confirm the output voltage and cyclic durability.

In this study, Thin-film amorphous silicon (a-Si) microbattery anodes are fabricated by low pressure chemical vapor deposition (LPCVD) using Si_2H_6 as source gas. The high reversible capacity and cycle performance are presented. Galvanostatic charge-discharge test of half cells were performed. Thin-film amorphous silicon anodes exhibited the highest reversible capacity (4000mAh/g), which is about 95% of the theoretical capacity in case of $Li_{22}Si_5$. The cyclability was enhanced by controlling the lower voltage limit or by reducing the amount of cycled charge quantity. The thin-film silicon anodes can successfully be coupled with thin-film $LiMn_2O_4$ cathodes, confirming that batteries have output voltage of 3.0 to 3.8V and good cyclic durability.