

## Preparation of Thin Films and Nanoparticles of Zinc Oxide Using Alkylzinc Alkoxides

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Alkylzinc alkoxides have been used in chemical vapor deposition (CVD) to deposit ZnO thin films. Due to the inherent  $\beta$ -hydrogen abstraction pathway, these precursors have been successfully employed in the preparation of ZnO nanoparticles without an extra oxygen source. Recently, we tested the possibility of using methylzinc isopropoxide as precursor for ZnO thin films by atomic layer deposition (ALD), with water as the source for oxygen. Under optimal deposition conditions, the self-limiting ALD process by a binary chemical reaction between methylzinc isopropoxide and water was confirmed with various characterization techniques. This suggests that alkylmetal alkoxides are potential sources for thin films and nanoparticles of metal oxides.

Various methods have been employed to prepare thin films of zinc oxide, but metal organic chemical vapor deposition (MOCVD) is supposedly the most suitable one for large area deposition. A few of the so-called metal organic compounds such as zinc acetate and zinc acetylacetonate, and alkylzinc alkoxides have been used. Others include diethylzinc and bis(2,2,6,6-tetramethyl-3,5-heptanedionato)zinc. ZnO thin films have been made by metal organic chemical vapor deposition using bis(2,2,6,6-tetramethyl-3,5-heptanedionato)zinc and oxygen in this laboratory. The difficulty in using this precursor was the fact that it had to be heated to a high temperature to obtain a reasonably high vapor pressure and oxygen was necessary as an oxygen source. It was recently confirmed that dimethylaluminum isopropoxide, together with water, is very useful as a source for aluminum oxide thin films by ALD. Therefore it is reasonable to think of using an alkylzinc alkoxide, a zinc analogue of alkylmetal alkoxides, and water for the deposition of ZnO thin films by their ALD process. It would be highly desirable if an alkylzinc alkoxide precursor could be found a usable precursor.

It would be interesting and convenient if one can prepare both nanoparticles and thin films of zinc oxide using only one simple precursor. Auld et al in 1994 showed that ZnO thin films could be deposited on soda lime glass substrates by using methylzinc isopropoxide (MZI) and methylzinc *tert*-butoxide. Therefore, in this study, we tested the possibility of using alkylzinc alkoxides in the preparation of nanoparticles by thermolysis and thin films of ZnO by MOCVD and ALD.

We have shown that alkylzinc alkoxides can be used as precursors for MOCVD of ZnO thin films, thermolytic preparation of ZnO nanoparticles, and ALD of ZnO thin films together with water as an oxygen source. The importance of preparing nanoparticles of ZnO by using the single precursor (methylzinc isopropoxide alone without the aid of an oxygen source is fully appreciated in this work. It has been speculated that this is due to the fact that the alkylzinc alkoxides have the inherent  $\beta$ -hydrogen elimination mechanism.

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