Atomic Layer Deposition of Thin Films for Microelectronics

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The atomic layer deposition (ALD) method (1-4) has recently gained a lot of interest as a potential future manufacturing technology for microelectronics. This is because the self-limiting film growth mechanism of ALD provides excellent conformality and uniformity over large areas, and atomic level control of film composition and thickness.

Though increasing number of groups are examining the applicability of the ALD method to microelectronics, a majority of these studies has focused to only a few well established processes: $Al(CH_3)_3$ - H_2O, $ZrCl_4$ - H_2O, $HfCl_4$ - H_2O, and $TiCl_4$ - NH_3. While the $Al(CH_3)_3$ - H_2O process is considered as a nearly ideal ALD process, the others have some limitations and drawbacks, thereby leaving room for new chemical approaches for depositing the corresponding materials. In addition, there is a whole range of other materials, like metals and ferroelectric oxides, for which efficient ALD processes should be developed. The wider use of ALD in microelectronics thus calls for development of appropriate processes for materials of an interest: high permittivity (high-k) and ferroelectric oxides, metals, and transition metal nitrides. In this presentation, the current status of ALD of microelectronics materials is reviewed and challenges for the future research are pointed out.

References
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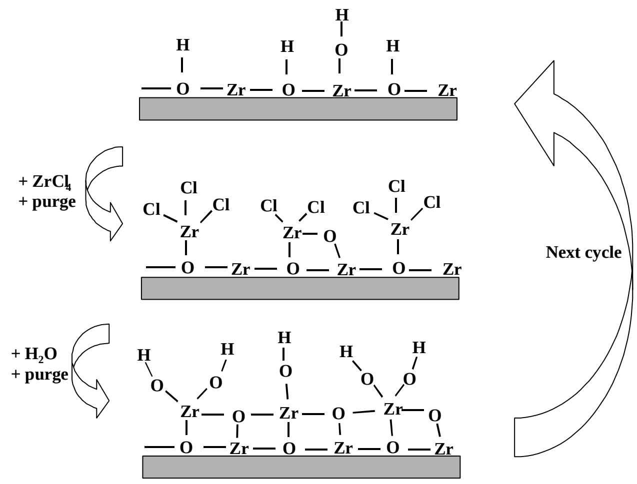

Figure 1. The basic principle of ALD shown schematically with the $ZrCl_4$ - H_2O process as an example.

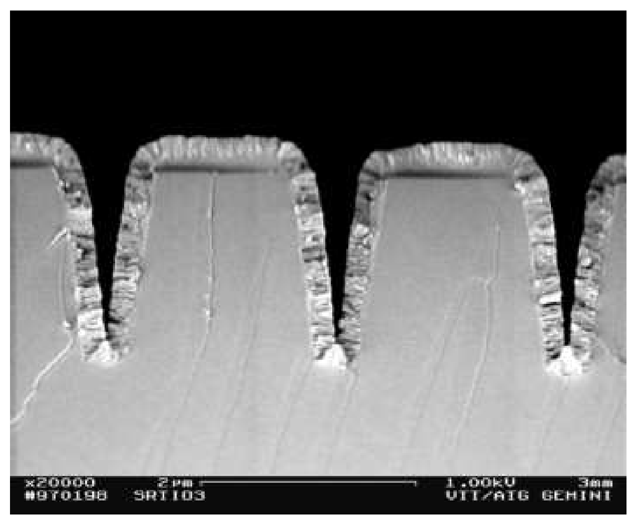

Figure 2. Cross sectional SEM image of a $SrTiO_3$ film on a trenched substrate showing the excellent conformality of ALD.