Advanced ALD and its applications

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Abstract: Recent advances in semiconductor devices have required extreme material properties. Atomic layer deposition (ALD), enabling the conformal deposition of ultrathin high-quality films on complicated and high aspect ratio platforms, has been widely adopted for manufacturing state-of-the-art semiconductor devices. However, it has become difficult to meet these requirements even with ALD as the physical dimension shrinks to a few nm scale. The most prominent problems are the low continuity of the metal films due to island growth and the high leakage current of the oxide films resulting from their ultrathin thickness. We proposed two advanced ALDs to overcome the limitations of conventional ALD; discrete feeding ALD (DF-ALD) [1,2] and electric potential-assisted ALD (EA-ALD)[3], and demonstrated improved properties of the films grown using advanced ALDs. DFM process consists of multiple steps of feeding and purging precursor molecules prior to the reactant feeding/purging step, which enables instant removal of physisorbed precursor molecules screening functional group on substrate, hence chemical adsorption efficiency and surface coverage can be improved. EA-ALD process also improves chemical adsorption and surface coverage by applying bias voltage on substrate during precursor/reactant injection. Electric field formed across ALD reactor increases impingement of precursor and modulated surface potential changes activation energy of ALD reaction on surface. BM-ALD process consists of only precursor injection without reactants, utilizing reactivity between two different precursor ligands, which enables deposition of bimetallic alloy. Additionally, composition and properties of bimetallic alloy was controlled by DFM. The detailed experimental procedures and results will be presented.

References:

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Prof. Tae Joo Park received the B. Eng and Ph. D degree in Materials Science and Engineering from the Seoul National University, Seoul, Korea, in 2002 and 2008, respectively. His research at Seoul National University covered electrical and chemical characterizations of advanced gate stacks with metal gate/high-k/high mobility channel and non-volatile memory applications as well as thin film growth using atomic layer deposition. From 2008 to 2010, he was a research scientist of the Materials Science and Engineering department at the University of Texas at Dallas, where he was involved in advanced nano-electronic devices based on organic/inorganic thin films, graphene layer growth, and *in-situ* XPS analysis of thin films. Since 2011, he is currently a professor in the Hanyang University, Korea. He has published more than 180 papers in technical journals with more than 270 presentations in international conferences. His research interests include nano-electronic devices, advanced ALD processes and energy storage systems.