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Plasma Processing of Functionally Enhanced Complex Material Systems at the Atomic Scale

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Functionally improved materials are driving the technological advanced in silicon based integrated circuits to enable the continued down-scaling of circuit density and performance enhancement in analog, logic, and memory devices. Plasma processing can enable the synthesis and patterning of these functionally enhanced materials, especially at the nanoscale. This paper will address both atomic layer deposition and atomic layer etching by plasmas. For atomic layer deposition, complex materials can be synthesized not only with elemental precision to achieve the desired functionality but also with outstanding conformality, by leveraging the self-limiting surface reactions. In this talk, I will discuss current research advances in atomic layer deposition for synthesizing multifunction and complex metal oxides with tailored electronic, chemical, interfacial, thermal properties and microstructures. For atomic layer etching, based on the thermodynamic screening, viable chemistries are tested experimentally to corroborate the theoretical prediction. Some of the above mentioned material systems such as magnetic materials used in non-volatile memory devices are used as examples to demonstrate the broad applicability of this approach.