Simulation of New Material-Systems for Directional Atomic Layer Etching

Ivan L. Berry, Keren J. Kanarik, Thorsten Lill, Vahid Vahedi, Richard A. Gottscho

(Lam Research Corporation)

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Atomic layer etching (ALE) has recently been introduced into manufacturing of 10 nm logic devices. ALE is an etching technology that deploys separated and self-limited steps. In directional ALE, at least one of the two steps has to be directional, i.e., has to transfer momentum to the surface and/or be sensitive to line of sight. Ion bombardment is most commonly used to realize directional ALE. ALE exhibits the same ion-neutral synergy as RIE but the removal amount is not flux dependent due to the separation of the neutral (chemical) and ion fluxes /1,2/. Flux independence gives ALE its most important property: inherent uniformity across all length scales – across wafer, loading, ARDE and surface smoothness. As compared to conventional plasma etching, the separate steps in ALE also offers a simplified system in which to study the basic etching mechanisms. For example, recently, the process window of ALE was shown to be predictable based on the energy barriers relevant to the substrate-reactant combination, such as the surface binding energies of the chemically modified and bulk material /3/. The separate and independent steps make it particularly suitable to modelling efforts. Here we present the latest results in feature scale modelling of new material systems amenable to the ALE approach.

[1] H.F. Winters, J.W. Coburn, E. Kay, J. Appl. Phys. 48, 4973 (1977)

[2] K.J. Kanarik et al., J. Vac. Sci. Technol. A 33(2) (2015)

[3] K.J. Kanarik et al., J. Vac. Sci. Technol. Submitted Dec 2016