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Atomic Layer Etching of Silicon to Solve ARDE-Selectivity-Profile-Uniformity Trade-Offs MINGMEI WANG, ALOK RANJAN, TEL Technology Center, America, LLC, PETER VENTZEK , Tokyo Electron America, Inc., AKIRA KOSHIISHI, Tokyo Electron Miyagi Ltd. — With shrinking critical dimensions, dry etch faces more and more challenges. Minimizing each of aspect ratio dependent etching (ARDE), bowing, undercut, selectivity, and within die uniformly across a wafer are met by trading off one requirement against another. At the root of the problem is that roles radical flux, ion flux and ion energy play may be both good and bad. Increasing one parameter helps meeting one requirement but hinders meeting the other. Self-limiting processes like atomic layer etching (ALE) promise a way to escape the problem of balancing trade-offs. ALE [1] was realized in the mid-1990s but the industrial implementation has been slow. In recent years interest in ALE has revived. We present how ARDE, bowing/selectivity trade-offs may be overcome by varying radical/ion ratio, byproduct re-deposition. We overcome many of the practical implementation issues associated with ALE by precise passivation process control. The Monte Carlo Feature Profile Model (MCFPM) is used to illustrate realistic scenarios built around an Ar/Cl_2 chemistry driven etch of Si masked by SiO_2. We demonstrate that ALE can achieve zero ARDE and infinite selectivity. Profile control depends on careful management of the ion energies and angles. For ALE to be realized in production environment, tight control of IAD is a necessary. Experimental results are compared with simulation results to provide context to the work. [1] Athavale et al., J. Vac. Sci. Technol. B, 14, 3702 (1996).

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