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Dual-RF-Mode Inductively Coupled Plasma (ICP) Source for Advanced Dry Etching Processes SAMER BANNA, ANKUR AGARWAL, VALENTIN TODOROW, SHAHID RAUF, KEN COLLINS, Applied Materials Inc. — Conventional industrial ICP sources for dry etching processes suffer inherently from the so-called M-shape etch rate (ER) pattern across the wafer. Such M-shape limits significantly the ER uniformity and the depth range of shallow trench isolation processes which are detrimental for processes in the 3x node technology and below. Among the commonly used ICP industrial sources are the cylindrical ones consisting of two vertical coils wound in a helical shape. In the latter the coils are wound at different diameters powered by 13.56MHz RF supply, enabling center-to-edge power deposition control. The two-coils' currents are in-phase, leading to a destructive interference in the magnetic field contributed by each coil in the region between the coils, which will be manifested as M-shape plasma density profile across the wafer. Recently, at Applied Materials Inc., we have developed a unique dual-RF-mode ICP source capable of controlling the current direction between the two coils to be either in-phase or out-of-phase. While being out-of-phase a constructive interference between the magnetic fields takes place providing a new regime of operation for which M-shape can be eliminated. Such ICP source enables flexible plasma density profile control and widens the operational window for advanced dry etching processes.

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