Directed Ribbon Beam Processing

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We review a new processing technology that uses a ribbon ion beam for materials engineering. We show how this technology is very well suited to 2D and 3D structures because it allows processing to be varied depending on surface orientation and/or position on the wafer.

Figure 1 shows a schematic of this new directed ribbon-beam processing tool. A source external to the process chamber provides a neutral and radical flux to the wafer as well as a ribbon beam of energetic ions, controlled by a pulsed DC bias supply. The ribbon beam is horizontal and the wafer scans vertically through it. The wafer is mounted on a rotating platen, so it can be rotated at the end of each pass through the beam. The ribbon beam has little or no structure along its length, but can be manipulated by the source extraction optics so that it is focused, diverging, or pointing up or down.

The unique capabilities of this tool come from the ability to control:

1) The angles (spread and direction) at which the energetic ions arrive at the wafer, which are controlled by the extraction optics.
2) The chemistry at the wafer by controlling the source gases, pressure, rf power and modulation.
3) The processing dose on the wafer which is controlled by the scan velocity and the duty cycle of the source rf and DC bias supplies.

We demonstrate, through several examples, how these capabilities can be used to solve major challenges to the semiconductor roadmap. We will discuss directional etching, photo-resist hardening, and improving chemical-mechanical polishing (CMP).

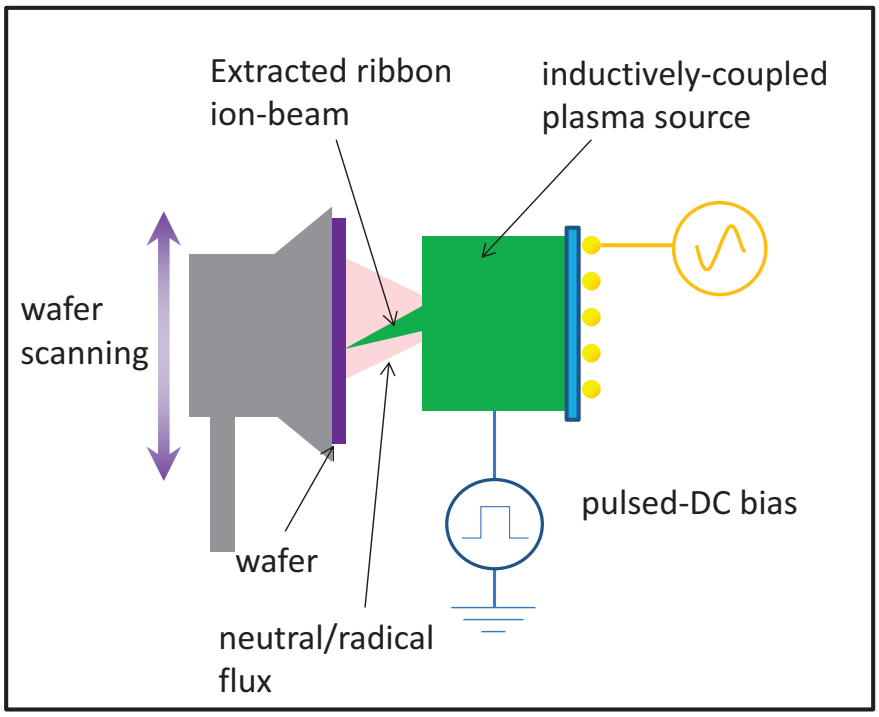

Figure 1. *Directed Beam Processing Tool*

The rf plasma chamber provides a source of neutrals and radicals to the wafer surface. Ions are extracted, using a dc bias, as a ribbon beam through an aperture at least as long as the diameter of the wafer. The distance from the scanned wafer to the source can be varied from a few mm to many cm.