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The Role of Plasma Science in Materials Processing

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Plasma science has repeatedly enabled fundamental advances in materials processing since the late 1960's when it found its first applications in the manufacture of semiconductor integrated circuits. There have been numerous industrial uses of glow discharge plasmas outside of the semiconductor industry (e.g., the manufacture of hard disk drives, textiles, and MEMS); however, this paper will only give attention to its relevance in the semiconductor industry. It will begin with a historical perspective on the relevance of glow discharge plasmas to etching and vapor (i.e., chemical and physical) deposition of thin films. This will include its first uses in the bipolar integrated circuit industry as well as its origins in more mainstream applications. Surprisingly, by 1985 there were already over twelve reactors being used for plasma etching. Next, this presentation will discuss the 1990's inception and misconceptions surrounding high density plasmas. Although many multi-frequency and multi-electrode (e.g., capacitive, inductive) plasma systems are commonly used today, only gap fill of dielectric thin films into small features currently utilizes a relatively high density plasma as typically defined by plasma science. The paper will conclude with a discussion of several current problems of great interest to the semiconductor equipment industry and discuss where limitations in plasma technology may impede Moore's law.