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The effect of radio-frequency bias on electron density in an inductively coupled plasma reactor, measured by a wave cutoff probe MARK SOBOLEWSKI, National Institute of Standards and Technology, JUNG-HYUNG KIM, Korea Research Institute of Standards and Science — Rf-biased, inductively coupled plasma reactors allow ion energy and ion flux to be varied separately, but it is unlikely that perfectly independent control can be achieved. Although rf bias is intended to only affect ion energies, it may also produce changes in the plasma electron and ion densities and the total ion flux. To provide a better understanding of such changes, we performed a detailed study in Ar, CF_4, and Ar/CF_4 plasmas. We measured the electron density with a wave cutoff probe, which avoids problems with deposition and rf compensation that may affect Langmuir probes. The effect of rf bias on electron density was measured as a function of source power, position, pressure, bias frequency, bias amplitude, and time. Cutoff probe results were also compared to Langmuir probe measurements, and both showed the same effects. Two types of bias-induced changes in electron density were observed. One was a gas composition effect caused by etch or sputter products liberated from the wafer surface. The other was an electron heating effect caused by absorption of bias power by plasma electrons. Simple models of each effect were derived and shown to yield quantitative predictions in agreement with the observations.

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