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Validation of Plasma Models – An Industrial Perspective

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Low T_e plasmas are widely used for thin film processing in the semiconductor industry. Modeling is an important tool for the design of these plasma systems. If one uses models to make plasmas uniform to within 1% over large substrates and control ion direction within 0.1, the models needs to sufficiently accurate. Plasma modelers are aware of the uncertainty regarding important fundamental data such as electron impact cross-sections and surface sticking coefficients. Experimental validation and calibration of plasma models are therefore critical to make them quantitatively accurate. Several examples are used to illustrate different methods for validating and refining plasma models in an industrial setting. Ideally, systematic plasma diagnostic measurements should be made on the actual plasma tool as was the case in our capacitive plasma source. n_e and T_e were measured using double probes in the 2 – 162 MHz range for many gases. Another option is to validate the models under similar conditions in a research reactor. For example, diagnostic data from Ecole Polytechnique in inductively coupled halogen plasmas was used to optimize plasma models for etch applications. Processing results (e.g., etch rate, profile) are often the most easily available data. Validating plasma models using such data relies on coupling the plasma simulations to surface chemistry mechanisms, which introduces its own challenges.