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**Real time closed loop control of an Ar and Ar/$O_2$ plasma in an ICP** R. FAULKNER, F. SOBERÓN, A. MCCARTER, D. GAHAN, S. KARKARI, V. MILOSAVLJEVIC, C. HAYDEN, A. ISLYAIKIN, V.J. LAW, M.B. HOPKINS, Dublin City University, Ireland, B. KEVILLE, P. IORDANOV, S. DOHERTY, J.V. RINGWOOD, National University of Ireland, Maynooth — Real time closed loop control for plasma assisted semiconductor manufacturing has been the subject of academic research for over a decade. However, due to process complexity and the lack of suitable real time metrology, progress has been elusive and genuine real time, multi-input, multi-output (MIMO) control of a plasma assisted process has yet to be successfully implemented in an industrial setting. A Splasma parameter control strategy T is required to be adopted whereby process recipes which are defined in terms of plasma properties such as critical species densities as opposed to input variables such as rf power and gas flow rates may be transferable between different chamber types. While PIC simulations and multidimensional fluid models have contributed considerably to the basic understanding of plasmas and the design of process equipment, such models require a large amount of processing time and are hence unsuitable for testing control algorithms. In contrast, linear dynamical empirical models, obtained through system identification techniques are ideal in some respects for control design since their computational requirements are comparatively small and their structure facilitates the application of classical control design techniques. However, such models provide little process insight and are specific to an operating point of a particular machine. An ideal first principles-based, control-oriented model would exhibit the simplicity and computational requirements of an empirical model and, in addition, despite sacrificing first principles detail, capture enough of the essential physics and chemistry of the process in order to provide reasonably accurate qualitative predictions. This paper will discuss the development of such a first-principles based, control-oriented model of a laboratory inductively coupled plasma chamber. The model consists of a global model of the chemical kinetics coupled to an analytical model of power deposition. Dynamics of actuators including mass flow controllers and exhaust throttle are included and sensor characteristics are also modelled. The application of this control-oriented model to achieve multivariable closed loop control of specific species e.g. atomic Oxygen and ion density using the actuators rf power, Oxygen and Argon flow rates, and pressure/exhaust flow rate in an Ar/$O_2$ ICP plasma will be presented.

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