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Current status of Atomic and Molecular Data for Low-Temperature Plasmas

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Control of plasma processing methodologies can only occur by obtaining a thorough understanding of the physical and chemical properties of plasmas. However, all plasma processes are currently used in the industry with an incomplete understanding of the coupled chemical and physical properties of the plasma involved. Thus, they are often 'non-predictive' and hence it is not possible to alter the manufacturing process without the risk of considerable product loss. Only a more comprehensive understanding of such processes will allow models of such plasmas to be constructed that in turn can be used to design the next generation of plasma reactors. Developing such models and gaining a detailed understanding of the physical and chemical mechanisms within plasma systems is intricately linked to our knowledge of the key interactions within the plasma and thus the status of the database for characterizing electron, ion and photon interactions with those atomic and molecular species within the plasma and knowledge of both the cross-sections and reaction rates for such collisions, both in the gaseous phase and on the surfaces of the plasma reactor.

The compilation of databases required for understanding most plasmas remains inadequate. The spectroscopic database required for monitoring both technological and fusion plasmas and thence deriving fundamental quantities such as chemical composition, neutral, electron and ion temperatures is incomplete with several gaps in our knowledge of many molecular spectra, particularly for radicals and excited (vibrational and electronic) species. However, the compilation of fundamental atomic and molecular data required for such plasma databases is rarely a coherent, planned research program, instead it is a parasitic process.

The plasma community is a rapacious user of atomic and molecular data but is increasingly faced with a deficit of data necessary to both interpret observations and build models that can be used to develop the next-generation plasma tools that will continue the scientific and technological progress of the late 20th and early 21st century. It is therefore necessary to both compile and curate the A&M data we do have and thence identify missing data needed by the plasma community (and other user communities). Such data may then be acquired using a mixture of benchmarking experiments and theoretical formalisms. However, equally important is the need for the scientific/technological community to recognize the need to support the value of such databases and the underlying fundamental A&M that populates them. This must be conveyed to funders who are currently attracted to more apparent high-profile projects.

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