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Laser-aided diagnostics of reactive plasmas for better understanding of material processing

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The roles of plasma diagnostics in the development of plasma- aided material processing are classified into two categories. One is to provide deep understanding of reactive plasmas, which is indispensable for the efficient development of new processing technologies via laboratory experiments. The other role is to monitor the operation conditions of plasma processing tools in factories in order to realize efficient mass production. Laser-aided diagnostics have mainly played the former role in the last two decades, but they have potential applications in plasma monitoring tools which are required strongly from the industrial point of view. In this talk, we will show two examples of laser-aided precise diagnostics for laboratory experiments and an example of laser-aided monitoring of reactive plasmas. The first diagnostics is the measurement of sheath electric field in an electronegative Ar/SF_6 plasma by laser-induced fluorescence-dip spectroscopy. We observed a stepwise electric field distribution which was induced by the localized reflection of negative ions. The second diagnostics is laser-induced fluorescence imaging spectroscopy. We visualized two-dimensional distributions of radical densities and the velocity distribution function of Fe atoms in magnetron sputtering plasmas. The final one is a method for estimating electron density and electron temperature of a processing plasma based on diode laser absorption spectroscopy. This method would be utilized as a plasma monitoring tool because of the low cost and the maintenance-free operation of the diode laser.