The potential of quantum cascade laser absorption spectroscopy for plasma technological applications in industry

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Recent applications of infrared absorption spectroscopy using quantum cascade lasers (QCL) for in situ diagnostic of plasma processes in industrial environments are reviewed. Examples which emphasize the capability of quantum cascade laser absorption spectroscopy (QCLAS) as plasma diagnostic technique in industrial environments will be given.

Nowadays molecular plasmas play a key role in branches of industry like semiconductor industry, automotive industry, mechanical engineering, light sources, and biomedical technology to name a few. Typical applications are thin film deposition, etching and structuring of semiconductor devices, surface treatment, like activation, passivation and cleaning, and materials and waste treatment as well. The intense use of plasma technological processes demands proper plasma diagnostic techniques for monitoring, controlling and optimization purposes in industrial environments. In particular due to the efficiency of the production process, in situ diagnostic techniques with online capabilities are favorable.

Mid infrared absorption spectroscopy between 3 and 20 µm using QCL has progressed considerably as a powerful diagnostic technique for in situ studies of the fundamental physics and chemistry of molecular plasmas [1]. QCLAS provides a means of determining the absolute concentrations of the ground states of stable and transient molecular species, which is of particular importance for the investigation of reaction kinetics. Since QCL emit near room temperature, i.e. without the need of cryogenic cooling, very compact and robust spectroscopic instruments can be designed. This has stimulated the adaptation of infrared spectroscopic techniques to industrial requirements [2-8].

The aim of the present contribution is to review recent achievements using QCLAS for plasma diagnostics and to emphasize the potential of QCLAS for plasma technological applications in industry.

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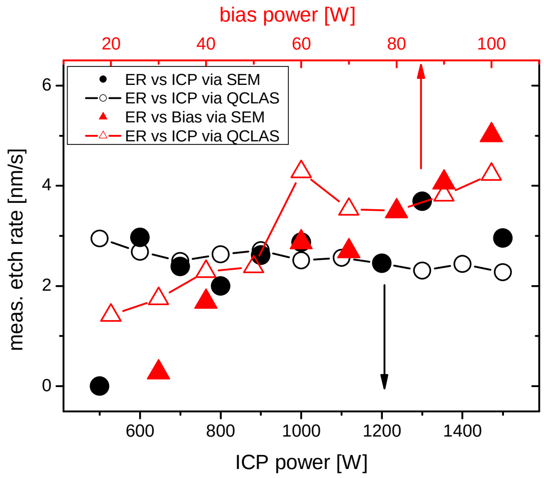

Fig. 1*: Example of in situ measured mean building rate of SiF_4 via QCLAS and comparison to ex situ determined etch rates for ultra low-k material (SiCOH) etched in a CF_4 plasma.[8]*

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