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A remote plasma spectroscopy based method for monitoring of Atomic Layer Deposition processes

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Atomic layer deposition (ALD) is an exciting emerging technology in the deposition of many functional thin films. Effective monitoring of individual gas concentrations during the ALD processes offer a unique insight into the process behaviour as well as being an important step in the eventual wide-spread industrialisation of the ALD technique. Conventional quadrupole residual gas analysers have difficulty monitoring ALD processes due to the high process pressures and the presence of contaminating hydrocarbons contained within many ALD precursors. For these reasons monitoring of precursor gas concentrations during the ALD process is rarely undertaken. An alternative gas sensing technique that operates directly at pressures above 1E^{-4} mbar has been built around plasma emission monitoring. This technique involves the generation of a small, remote plasma using an inverted magnetron placed within the ALD vacuum system. Consequently, species that are present within the vacuum become excited in the sensor's plasma, emitting a spectrum of light, which can then be used to identify and monitor the emitting species.

This work will demonstrate that the sensing method is robust when exposed to the ALD processing environment. Photomultiplier and CCD spectroscopy based methods were investigated for analysing the plasma emission. It was found that by synchronising the spectrum acquisition with the precursor injection, it was possible to consistently capture the fast gas dynamics of the ALD process. Sensitivity limitations of the technique are also investigated, in particular the effectiveness of plasma emission monitoring in being able to distinguish between similar precursors. Examples of this sensing technique's practical uses for ALD processes are discussed; this includes detection of contaminants, optimising purge cycle length and monitoring the reaction dynamics in terms of precursor gas consumption.

Keywords

ALD

RGA

Plasma emission monitoring

Process control