Emission Characterization of Advanced CVD Processes and Abatement Performance

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The introduction of novel precursors for chemical vapor deposition (CVD) processes increasingly requires accompaniment of on-line analytical instruments to reduce development cycle-time and for process optimization. Furthermore, economics motivate adaptation of existing abatement devices to novel chemistry process exhaust. Confirmation that abatement performance is effective should be made using analytical measurements. Conversely, monitoring of new processes could lead to alternative choices for abatement of problematic compounds.

This report describes the characterization of CVD processes including evaluation of abatement efficiency on novel CVD processes. Presented is process characterization of bis(tertiary-butylamino)silane (BTBAS), a chlorine-free liquid precursor for low-pressure chemical vapor deposition (LPCVD) of uniform silicon nitride, silicon oxynitride and silicon dioxide films at low temperature. Performance of the chemical decomposition/ oxidation (CDO) device used to abate BTBAS and BTBAS byproducts is also shown.

Also described is process characterization of tetrakis-dimethylamino titanium (TDMAT), a liquid chemical source for the chemical vapor deposition of titanium nitride films used as barriers. Performance of the CDO device used to abate TDMAT precursor and byproducts is also shown.

Abatement efficiency of a hot-bed reactor is also shown for a process using titanium tetrachloride ($TiCl_4$) a liquid source material for the chemical vapor deposition of titanium nitride, titanium dioxide, or titanium metal.

Data were collected using quadrupole mass spectrometry (QMS) for process monitoring and Fourier transform infrared spectroscopy (FTIR) for emissions characterization downstream of the mechanical pump. The QMS was equipped with a heated flexible bellows to admit sample from the chamber. The FTIR is equipped with a dual cell assembly (10 cm and 10 m pathlengths) and a pneumatically-switchable optical path to permit rapid access to two optical densities. This is especially useful when accessing two concentration regimes, e.g. the input and output of an abatement device. Where possible, filters and a cold trap were used to protect instrumentation and facility exhaust infrastructure from particle contamination and moisture.

Figures

Figure 1: FTIR spectra from the inlet and outlet of abatement device on LPCVD BTBAS process.

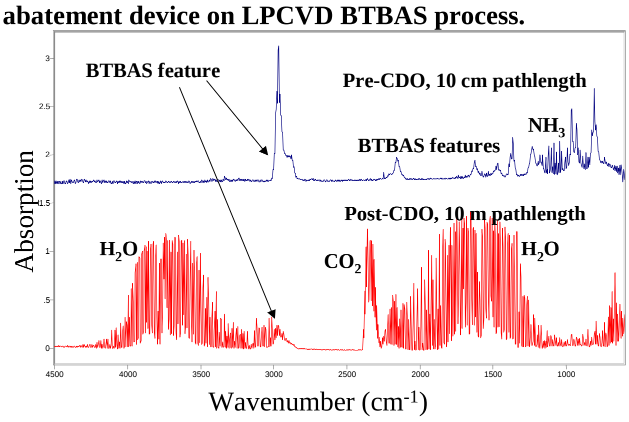


Figure 2: FTIR spectral plot during evolution of TiN deposition process using TDMAT precursor.

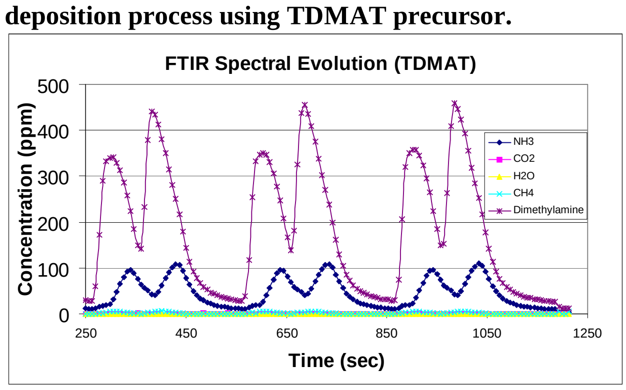
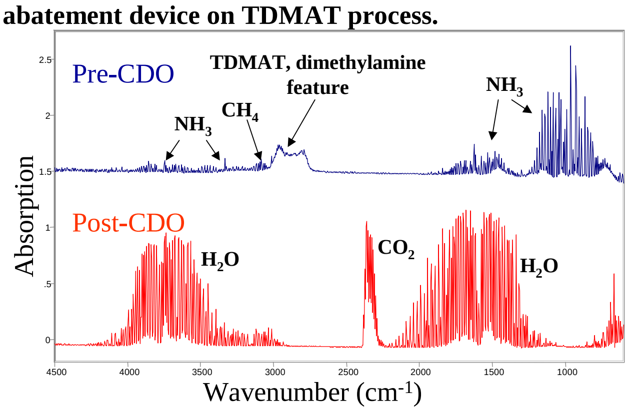


Figure 3: Spectra from the inlet and outlet of abatement device on TDMAT process.



References

L. Mendicino, V. Vartanian, B. Goolsby, P.T. Brown, K. Reid, and J. V. Gompel, Proceedings of the 4th International Symposium on Environmental Issues With Materials and Processes for the Electronics and Semiconductor Industries, 199th Meeting of the Electrochemical Society, March 2001, Washington, DC, pp 68-77.