SPECTROSCOPY AND DYNAMICS OF SEMICONDUCTOR GROWTH INTERMEDIATES

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Gas phase reactive intermediates play an important role in various semiconductor growth processes, such as chemical vapor deposition and plasma etching. We have been studying the spectroscopy and dynamics of such intermediates, in order to establish reliable data for experimental and theoretical attempts at optimizing industrial processes. We have succeeded in producing jet-cooled UV-visible spectra of SiF_2, $SiCl_2$, HSiF, HSiCl, HSiBr, GeH_2, $GeCl_2$, GeF_2, HGeCl and HGeBr with resolution sufficient to resolve the vibrational and, in most cases, the rotational structure in the S_1 - S_0 spectra. Analyses of these spectra have yielded the vibrational frequencies, rotational constants and sructures of the silylenes and germylenes, resolving a number of anomalies in the literature. The much weaker T_1 - S_0 spectra of GeF_2, $GeCl_2$ and SiF_2 have also been observed; in the SiF_2 case we have obtained rotationally resolved spectra, triplet spin constants and a precise r_0 structure. In other work relevant to SF_6 low pressure plasma etching processes, we have detected the FS_2 radical for the first time. The spin constants and structural parameters of the combining states were obtained from the rotational analysis of high-resolution jet spectra. Most recently, we have obtained spectra of the S_2 - S_0 transition of silylidene, $H_2C{=}Si$, and determined the ground and excited state structures and some of the vibrational frequencies. Silylidene has a variety of fascinating photophysical properties, including anomalous emission from the S_2 state, rotational level specific quantum yields of fluorescence and extensive fluorescence quantum beats.