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 SiF₂, SiCl₂, HSiF, HSiCl, HSiBr, GeH₂, GeCl₂, GeF₂, HGeCl and HGeBr with resolution sufficient to resolve the vibrational and, in most cases, the rotational structure in the S₁ - S₀ spectra. Analyses of these spectra have yielded the vibrational frequencies, rotational constants and structures of the silylenes and germynes, resolving a number of anomalies in the literature. The much weaker T₁ - S₀ spectra of GeF₂, GeCl₂ and SiF₂ have also been observed; in the SiF₂ case we have obtained rotationally resolved spectra, triplet spin constants and a precise τ₀ structure. In other work relevant to SF₆ low pressure plasma etching processes, we have detected the FS₂ 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 S₂ - S₀ transition of silylidene, H₂C=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 S₂ state, rotational level specific quantum yields of fluorescence and extensive fluorescence quantum beats.