IR SPECTROSCOPY OF GAS PHASE METAL CLUSTERS

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A method for obtaining vibrational spectra of gas phase metal compound clusters is presented. The clusters are produced in a standard laser vaporization source. The cluster beam enters the interaction region with an IR laser, situated between the plates of a reflectron time-of-flight mass spectrometer. The IR laser is the "Free Electron Laser for Infrared eXperiments" (FELIX) [a], which is continuously tunable over the 5–250 μm wavelength region. The laser output consists of "macropulses" of about 5 μsec duration at a repetition rate of 10 Hz. The macropulse is composed of a series of picosecond duration "micropulses" spaced by one nanosecond. The macropulse energy can be up to 100 mJ, while the bandwidth is about 0.5 – 1 % of the selected wavelength. The IR beam is focused on the molecular beam with a 7.5 cm focal length gold mirror. When the laser wavelength is resonant with an infrared active mode, the cluster can be heated via multiple absorption of photons. In clusters with strong bonding and a relatively low ionization energy electron emission can become competitive with, or even dominant over, dissociation. Tuning the laser while measuring the mass-analyzed ion yield produces an infrared spectrum of the neutral cluster [b]

For titanium-carbide clusters [c], the IR spectra showed the presence of C–C bonding in Ti_8C_{12} clusters, supporting the postulated "Met-Car" structure. Larger clusters show distinctively different spectra that are in good agreement with the proposed nano-crystal structures. Results from several other metal compound systems will be presented.

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[b] G. von Helden, I. Holleman, G.M.H. Knippels, A.F.G. van der Meer, and G. Meijer, *Phys. Rev. Lett.* **79**, 5234 (1997).
[c] D. van Heijnsbergen, G. von Helden, M.A. Duncan, A.J.A. van Roij, and G. Meijer, *Phys. Rev. Lett.* **83**, 4983 (1999).