PROGRESS REPORT-YEAR ONE**GENERATION, DETECTION AND CHARACTERIZATION
OF GAS-PHASE TRANSITION METAL AGGREGATES AND COMPOUNDS**

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The goal of our research is to employ spectroscopic techniques to characterize the bound portions of the potential energy surface (PES) for chemical systems involving diatomic and triatomic transition metal molecules. The approach incorporates the generation and isolation of new metal compounds via supersonic laser ablation molecular beam techniques. Detection and characterization is achieved using high resolution dye laser induced fluorescence spectroscopy. A major objective is to produce information which can be compared to theoretical predictions and thereby provide guidelines and insight into the development of reaction models.

Description of Research Effort

Our experimental approach is to generate gas-phase diatomic and triatomic mixed metal molecules in only one vibronic state and a relatively small number of rotational levels, i.e. internally "cold". This "cold" sample is prepared via either a laser ablation [1-4] or a "pick-up" [5] supersonic expansion source. The molecular expansion is skimmed resulting in a well collimated molecular beam of non-interacting metal clusters and/or metal containing compounds. Approximately 20 cm from the expansion source tunable cw-dye laser induced fluorescence is detected by photon counting techniques. The coinage metals (Cu, Ag, and Au) are of particular interest because of their catalytic properties and their predicted high stability. All of our efforts in these early stages of this project have been directed at producing "cold" molecular beams of mixed coinage metal molecules and detecting them by LIF techniques.

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Figure 1. The laser ablation molecular beam spectrometer under construction. A super-sonic molecular beam of transition metal molecules will be generated by ablation of a solid target rod. Laser induced fluorescence excitation followed by photon counting detection will be used to characterize the molecules.

A block diagram of the molecular beam spectrometer under construction is given in Figure 1. It is designed to operate at repetition rate of 20 Hz, have the capability of LIF detection at a variable distance from the source and be compatible with either a continuous or pulsed dye laser excitation. The following aspects required to bring this spectrometer on line have been achieved.

- 1) The Nd:YAG ablation laser procured and interfaced to the computer system.
- 2) The vacuum system (6" diffusion pump with mechanical backing pump) constructed and pumped down.
- 3) A tunable pulsed dye laser system constructed and interfaced to computer system. The development of the wavelength calibration is in progress.
- 4) Gated photon counting system has been procured and computer interfacing in progress.
- 5) Pulse valve driver and timing circuit constructed.

We have had to make modifications to a laboratory adjacent to my existing facility in order to accommodate this apparatus. These modifications include installation of power for the vacuum pumps and cooling water for the laser systems. These accommodations are scheduled to be completed in early April and the various components will be relocated into these new facility soon thereafter.

Concurrent with the experimental effort we have been meeting with Prof. K. Balasubramanian and critically evaluating the existing theoretical data base for the mixed coinage metal clusters. This has proven valuable in establishing experimental parameters such as possible laser excitation and detection wavelengths. Furthermore, a recent visit by Prof. Mike Morse (U. Utah) proved to be valuable. Prof. Morse has produced REMPI spectra of some of the mixed metal clusters.

References

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