Introduction

Control of the DMS flow rate is independently maintained through an external pumping chamber positioned between the DMS and the commercial MS (a Thermo LCQ). The interface design must flexibly accommodate the front end home-built DMS cell. We base our initial adaptable DMS design with two stainless steel electrodes within housing fabricated from Veigel. The DMS mounts through a face-mounted o-ring to maintain a leak-tight transmission from the DMS into the interface. The resulting DMS-to-MS interface was designed in Solidworks and fabricated in PVC by the USF Engineering Center’s Machining Facilities.

Conclusions

We have begun iterating preliminary designs to systematically introduce metal cations into a home-built DMS-MS system. While access to a laser ablation regime for ion production did not appear achievable with the low powers of our current laser capabilities, a desorption ionization mechanism such as that leveraged in AP-MALDI may provide us optimal dry conditions for more robust ion introduction into DMS. To further systematically control DMS operational conditions, we also sought to independently constrain DMS flow by building, into the existing interface design, a port to provide external pumping. The interface design further allows us to adapt a DMS chamber, itself designed to simply and efficiency transfer ions.

Acknowledgements

This work was supported by the Defense Threat Reduction Agency, Basic Research Award HHDTRA1-11-1-0012.

References


Methods

The DMS housing features through a shelf-mounted o-ring assembly to accommodate a potential enclosed reaction chamber, monitored for DMS gas conditions. Ultimately the reaction cell shall interface directly with multiple API sources including both nonspray and laser desorption ionization. We design an optical path to constrain ablation of samples from bare metal standards.

Hypothetical Separation of Metals

The separation capability of DMS can be described by the ‘alpha function’ which depends on the field strength, which is the ratio of E (electric field) to N (gas density):

\[ K(E/N) = K(0)[1 + a_E(E/N) + a_N(E/N)^2] \]

where \( K(0) \) is the coefficient mobility of ions at low (E = 0) electric field conditions, and the alpha coefficients: \( a_E, a_N, a_{EN} \), are dependent on the E/N usually represented by the Townsend number (1 Td = 10^{-11} V·cm⁻²).

We have reported earlier on the feasibility of DMS to pre-filter inorganic ions toward the identification of radionuclide components in nuclear forensic applications. The alpha parameter for metal ions from the mobility tables by Ellis et al. 2–3, we applied DMS modeled in SIMION; the expanded x-y plane cross-sectional view shows the carrier gas and ion as they travel through the electrodes of the DMS.

Ambient Laser Ionization

Nanospray ionized samples can be introduced in an open air configuration ahead of DMS. Dissolved salt samples are supplied to a nESI needle with the help of a syringe pump. However, the specific ionization of ions cannot be easily constrained in this manner though it is likely that control of humidity is critical to achieving reproducibility. Thus we sought to produce minimally solvated ions from a laser ionization configuration from surfaces.

Future Directions

We intend to ultimately design and fabricate a reaction chamber to rigorously monitor and control the ion-cluster formation. We will employ a calibrated vapor generator to control the DMS carrier gas humidity independently from the ionization source through this chamber. This design shall be facilitated by fluid dynamic modeling of gas transport supported by ion transport models through SIMION. Experimental data obtained from the \( V_s \) and \( V_b \) transmission conditions shall be translated to their effective alpha parameters for comparison. Expansion of this work towards optimized laser ionization for nanoelectrospray conditions will help to determine internal conditions impacting DMS separation from water clustering phenomena. We intend to correlate water-mitigated DMS metal ion behavior with chemical modeling to further complement ion mobility analyses. Additionally, assembly of simplified, non proprietary COTS electronics are anticipated to achieve higher E/N values and thereby extend the understanding of cluster behavior from hydration energies.

This work was supported by the Defense Threat Reduction Agency, Basic Research Award HHDTRA1-11-1-0012.