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Innsbruck Physics Colloquium

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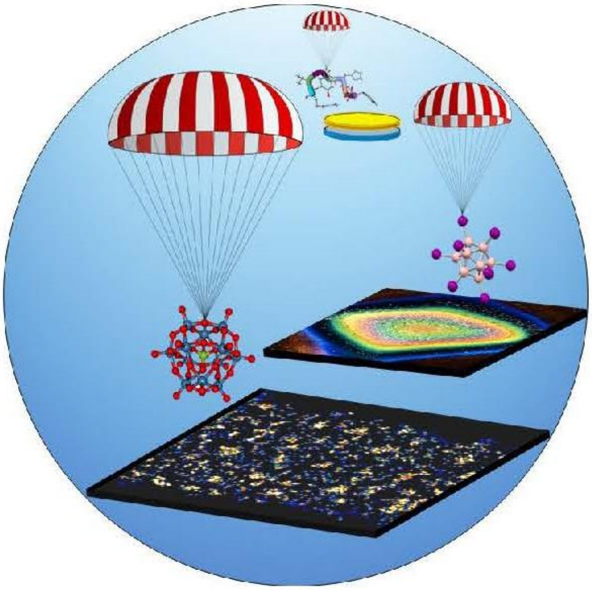
Rational Design of Solid Interfaces Using Soft-landing of Mass-Selected Ions

The deposition of complex molecules and clusters on supports plays an important role in materials science, energy production and storage, physics, and biology. Ion soft-landing, in which intact polyatomic ions are deposited onto surfaces with or without retention of charge, is a unique tool both for fundamental studies of ion-surface interactions and for the controlled preparation of layered architectures. The ability to select the mass-to-charge ratio of the precursor ion, its kinetic energy, and charge state along with precise control of the size, shape, and position of the ion beam on the deposition target makes soft-landing an attractive approach for surface modification. High-purity uniform thin films on surfaces generated using this technique facilitate understanding of critical interfacial phenomena relevant to catalysis and materials science. Experimental studies of charge retention by complex ions on surfaces have demonstrated efficient charge retention by anions and relatively facile charge loss by cations soft-landed onto self-assembled monolayer surfaces. These findings provide the scientific foundation for the rational design of interfaces for advanced catalysts and energy storage devices. Recent developments of the soft-landing instrumentation have enabled high-coverage deposition of ions, which revealed previously unknown collective phenomena, which could not have been predicted based on the properties of isolated ions. In particular, high-coverage deposition of anions was shown to generate liquid-like layers, which undergo self-organization upon exposure to laboratory air. This process was attributed to the dissipation of the image charge, which stabilizes charge-imbalanced layers generated using anion soft-landing. High-coverage deposition of cluster anions provides access to unique layered materials with self-organization properties controlled by the electronic properties of the anion. Recent developments in our laboratory have enabled co-deposition of positive and negative ions providing a path for generating layers with the controlled extent of charge imbalance. These findings provide a path for the controlled design of layered architectures using mass-selected ion deposition.



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