Vacuum Technology
Room Ballroom BC - Session VT-ThP

Vacuum Technology Poster Session

VT-ThP-1 Deposition and Sublimation of Argon Sphere Immersed in a Non-Condensable Gas Over an Wide Range of the Knudsen Number*, Felix Sharipov,* Universidade Federal do Paraná, Physics Department, Brazil*; Denize Kalempa,* Universidade de Sao Paulo, Brazil*; Irina Graur,* Aix-Marseille University, France

Rarefied gas flows involving phase transitions on solid surfaces are of both scientific and practical interest, particularly, for the development and optimization of vacuum systems, heat exchangers, and chemical reactors, etc. For example, heat and mass transfer driven by the sublimation of solid particles plays a crucial role in advancing technologies based on chemical vapor deposition in vacuum chambers. In the kinetic theory of gases, evaporation and condensation, analogous to sublimation and deposition, have been extensively studied using the Boltzmann equation and the Direct Simulation Monte Carlo method. However, most existing studies rely on simplified models with hypothetical molecular masses and the hard-sphere potential for intermolecular interactions. In this work, we consider a solid argon sphere surrounded by its vapor and helium as a background gas. The temperature and pressure of the mixture are set such that argon undergoes sublimation or deposition, while helium solely reflects off the solid surface. To capture flow regimes ranging from free-molecular to transitional and viscous, we employ a kinetic model for the linearized Boltzmann equation to compute mass and heat transfer from the argon sphere to the surrounding gas mixture. To assess the influence of interatomic interactions on the flow dynamics, calculations are performed using both the hard-sphere model and ab initio potentials. The results demonstrate that the partial pressure of helium significantly impacts the mass and energy transfer rates from the particle due to phase transitions occurring on its surface.

VT-ThP-2 Experimental Characterization of Water Outgassing Energetics on Bare and Magnetite-Coated Low-Carbon Steel Surfaces*, Aiman Al-Allaq,* ODU - Jefferson Lab*; Md Abdullah Al Mamun, Matthew Poelker,* Jefferson Lab*; Abdelmageed Elmustafa,* ODU

This work presents a detailed experimental setup and methodology for comparative outgassing analysis between bare and magnetite-coated AISI 1020 low-carbon steel chambers. Using a custom-built throughput apparatus, we measured outgassing rates under various thermal conditions. Binding energies obtained through Sips isotherm modeling (0.9-0.97 eV for bare steel, 1.12-1.24 eV for magnetite) and activation energies derived from rate-of-rise accumulation measurements (0.33-0.68 eV for both surfaces) provide complementary perspectives on the energy landscape governing water interactions with these surfaces. The difference between these energy parameters offers insight into the shape of the potential energy diagram, revealing the height of the desorption barrier relative to the adsorption well depth. This comprehensive energetic picture helps explain the counterintuitive finding that magnetite, despite its higher binding energy, exhibits worse outgassing performance after thermal treatment. Our analysis demonstrates how the combination of throughput measurements and multiple energy characterization techniques creates a more complete understanding of surface-gas interactions critical for vacuum system optimization. This approach provides both fundamental insights into desorption processes and practical guidance for thermal treatment protocols in vacuum applications requiring extremely low outgassing rates.

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