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Study of Release Properties of Sn, Ag, and Pd in an Upgraded Inductively Heated Hot Cavity Laser Ion Source

The region surrounding the doubly magic nucleus ^{100}Sn, particularly on the proton-rich side beyond the \(N=50\) shell closure, provides a crucial test ground for modern nuclear structure models. It offers access to fundamental phenomena such as isospin symmetry breaking, nucleon pairing, shell evolution, and the influence of the tensor force and Wigner energy [1]. Despite its importance, this region remains experimentally underexplored due to the significant challenges associated with producing and extracting short-lived, proton-rich isotopes with high efficiency.

To address these challenges, we conducted systematic studies of the production and release of Ag, Sn, and Pd isotopes using an upgraded inductively heated hot-cavity laser ion source (HCLIS) at the IGISOL facility. These investigations serve as essential precursors to precision laser spectroscopy and high-resolution mass measurements of isotopes near the \(N=Z\) line.

In the experimental setup, stable beams of Ag and Sn at 495 MeV from the K130 cyclotron were implanted in the HCLIS, evaporated, and resonantly ionized via multistep laser excitation. The resulting ions were accelerated to 30 kV, mass separated, and detected at the focal plane using either a Faraday cup or a microchannel plate (MCP) detector. Overall ionization and extraction efficiency was quantified by comparing the implanted beam current to the yield of mass-separated ions. Ion time profiles were recorded using a time-to-digital converter (TDC), synchronized via pulsed primary beam control.

For Pd, the release results were obtained from radioactive ^{99}Pd, which was produced via fusion-evaporation reactions. In the same experimental campaign, ^{92}Pd at the \(N=Z\) line was produced and its mass was measured directly for the first time with a MR-ToF mass spectrometer. Complementary COMSOL and Monte Carlo simulations are underway to model isotope effusion and transport dynamics within the HCLIS system.

The preliminary results demonstrate a total release and ionization efficiency of approximately 10% for Ag, with extraction times on the order of a few milliseconds. The efficiencies for Sn and Pd were around 5%, with Sn released within 350 ms and Pd within several seconds. These findings validate the performance of the HCLIS system and demonstrate its suitability for future spectroscopic studies in the proton-rich \(N=Z\) region near ^{100}Sn. Moreover, the measurements provide essential input for optimizing the design of target-ion source systems in upcoming experimental campaigns.

[1] Otsuka, T. *et al.*, *Evolution of shell structure in exotic nuclei*, Rev. Mod. Phys. 92, 015002 (2020).

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