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Enhancing Target Development at GANIL for Nuclear Research: Optimization of the Deposition Technique for Lanthanide Targets

The GANIL (Grand Accélérateur National d'Ions Lourds) facility plays a crucial role in nuclear physics, astrophysics, and materials science by providing high-quality ion beams for cutting-edge research. A key component of these experiments is the production of high-quality targets, which are essential for obtaining accurate and reproducible results. With the development of the SPIRAL2 facility, including the superconducting linear accelerator (LINAC) and experimental areas such as Neutrons for Science (NFS) and the Super Separator Spectrometer (S3), the demand for robust and precisely engineered targets has increased. To support this expanding experimental program, the GANIL target laboratory is undergoing a major upgrade to enhance its production and characterization capabilities, focusing particularly on isotopically enriched targets capable of withstanding high beam intensities.

To meet these challenges, various fabrication techniques, including physical vapor deposition (PVD), electrodeposition, and mechanical rolling, are employed to tailor targets with controlled thickness, composition, and mechanical stability. This work focuses on the development of lanthanide targets (Yb, Gd, Hf, etc.) using PVD techniques. The deposition process was optimized to ensure high-quality thin-film targets on ultra-thin carbon foils (35 $\mu g/cm^2$), which require careful handling to prevent damage. The high melting point of the oxide form of some elements, combined with the need for uniform deposition over large surfaces (16 cm^2), presents significant challenges. To overcome these, a rotation system was integrated into the deposition chamber, ensuring homogeneity. The fabricated targets undergo characterization through X-ray fluorescence (XRF) and scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX) to assess their uniformity and purity, ensuring they meet experimental requirements.

Preliminary results indicate promising advances in lanthanide target fabrication, with ytterbium targets exhibiting excellent adhesion and homogeneity. The achieved thickness range, from a few $\mu g/cm^2$ to mg/cm^2, fulfills the diverse needs of nuclear physics experiments.

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