ABSTRACT

X-ray gain experiments at $\lambda \sim 200\text{Å}$ in laser-induced exploding selenium foil targets were successfully demonstrated at LLNL's Novette laser facility in 1984. Recent experiments at KMS were designed to examine parameter variations of target thickness, laser duration and intensity, and one-sided vs two-sided irradiation, as a means of improving the performance of the gain experiments. Preliminary experiments were also performed on double-foil targets in attempts to prolong the duration and spatial extent of the x-ray lasing conditions in the space between the two foils. Four-frame holographic interferometry was used in determining the time dependence of the evolving density profiles obtained by Abel inversion of the interferometric fringe field and x-ray crystal spectroscopy was applied to monitor the x-ray emission.

SCOPE OF EXPERIMENTS

The principal experimental objective was to make use of KMSF's multiframe holographic interferometric capability to determine the temporal evolution of plasma density profiles for two-sided vs one-sided laser irradiation of Formvar foil targets, coated on one side with selenium, together with concomitant variations in laser pulse length, intensity and target component thicknesses. These profiles could then be used in checks of code simulations of planar and, particularly, cylindrically symmetric plasmas, useful in x-ray laser gain geometries. Of special interest was the desire to determine the extent to which exploding foil theory was applicable in two component targets of various thicknesses and irradiation conditions.

Concurrent determinations of temperature profiles, though very informative, were not conducted at this time.
TARGETS

The plasma distribution that was employed in the successful selenium x-ray lasing experiments at Livermore was cylindrical, generated by focusing the laser beams into a line. Interferometric determinations of density can be done using Abel inversion techniques, for which deconvolution of interferograms using this technique requires the density distributions to be either spherical or axi-symmetric. This condition is more easily realizable if the targets and their laser irradiation patterns are concentric disks. Comparisons to cylindrical density profiles would then have to be made via code simulations. Since interferometric measurements were required close to the two target surfaces, the simple disk target supported by a washer was not adequate, since one of the surface regions could not be probed by the holographic laser pulse. A new target design, as seen schematically in Fig.1, was developed using 150μm nickel wire bent to hold the stretched Formvar containing the deposited Se disks. With no support structure to interfere with the interferometric probe beam, plasma density profile measurements could be made near both surfaces of the target.

Selenium metal was evaporated as 300μm diameter disks on to 350μm wide Formvar strips. Nominal target component thicknesses consisted of:

A-Targets: 500 Å Se on 500 Å Formvar
B-Targets: 750 Å Se on 500 Å Formvar
C-Targets: 1500 Å Se on 500 Å Formvar
D-Targets: 750 Å Se on 1500 Å Formvar
E-Targets: 1500 Å Se on 1500 Å Formvar

For each fabricated target the densities, in μg/cm² for both selenium and its Formvar substrate, were determined using witness plates during the coating process. Using microradiography local thickness variations of the selenium coatings and their Formvar substrates were determined to be within 5-8% of their nominal values.

![Fig.1 Schematic of the Se/Formvar target design.](image)