Ni-lined Capsules as Backlighters for Multiple Measurements in High-energy-density Physics Experiments


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X-ray measurements are needed to probe high-energy-density plasmas


Extended X-ray Absorption Fine Structure[3]
X-ray Thomson Scattering[4]

- X-rays can probe interior states of high density plasmas
- Line and continuum are used for different diagnostics
- HEDP experiments typically make a single measurement
- Multiple measurements require complex geometries

Laser-driven capsule implosions produce a bright, short-duration x-ray pulse

- Lasers ablate the plastic and rocket effect launches converging flows
- Flows converge, converting kinetic energy to thermal energy
- Hot, dense plasma emits bremsstrahlung
- Rebound shock expands and cools the plasma

Ni lining the interior surface of the capsule allows for dual use source

- Ni provides possibility of line emission > 7.5 keV
- Dense, imploded Ni provides bright continuum between 2-6 keV: Bremsstrahlung ∝ Z^2
- Plastic layer tamps Ni and becomes transparent

1D rad hydro simulations in Helios-CR with LTE conditions and multi-group diffusion radiation transport

Spectral calculations trace a single ray with a 10x10 table in density and temperature for opacity

Experiments show bright continuum emission and weak line emission

- Adjusting the layer thicknesses suggest moderate changes to diameter and stagnation time
- Lower mass leads to significant increase in total flux leaving Ni
- Pancake implosion should enhance emission in optically thick dimension[5]

Future Work

- Consider effects of photoionization in Ni layer near stagnation
- Additional experiments in 2021 to test line enhancement techniques

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References