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Fluorescence and absorption spectroscopy for warm dense matter studies and ICF plasma diagnostics

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The burning core of an inertial confinement fusion (ICF) plasma at stagnation is surrounded by a shell of warm, dense matter whose properties are difficult both to model (due to a complex interplay of thermal, degeneracy, and strong coupling effects) and to diagnose (due to low emissivity and high opacity). We demonstrate a promising technique to study the warm dense shells of ICF plasmas based on the fluorescence emission of dopants or impurities in the shell material. This emission, which is driven by x-rays produced in the hot core, exhibits signature changes in response to compression and heating. High-resolution measurements of absorption and fluorescence features can refine our understanding of the electronic structure of material under high compression, improve our models of density-driven phenomena such as ionization potential depression and plasma polarization shifts, and help diagnose shell density, temperature, mass distribution, and residual motion in ICF plasmas at stagnation. Sandia National Laboratories is a multi-mission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC., a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA-0003525. This work was supported by the U.S. Department of Energy, Office of Science Early Career Research Program, Office of Fusion Energy Sciences under FWP-14-017426.