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Target design for materials processing very far from equilibrium*

JOHN J. BARNARD, LLNL, THOMAS SCHENKEL, LBNL — Local heating and electronic excitations can trigger phase transitions or novel material states that can be stabilized by rapid quenching. An example on the few nanometer scale are phase transitions induced by the passage of swift heavy ions in solids where nitrogen-vacancy color centers form locally in diamonds when ions heat the diamond matrix to warm dense matter conditions at ˜0.5 eV [1]. We optimize mask geometries for target materials such as silicon and diamond to induce phase transitions by intense ion pulses (e. g. from NDCX-II [2] or from laser-plasma acceleration). The goal is to rapidly heat a solid target volumetrically and to trigger a phase transition or local lattice reconstruction followed by rapid cooling. The stabilized phase can then be studied ex situ. We performed HYDRA [3] simulations that calculate peak temperatures for a series of excitation conditions and cooling rates of crystal targets with micro-structured masks. A simple analytical model, that includes ion heating and radial, diffusive cooling, was developed that agrees closely with the HYDRA simulations. The model gives scaling laws that can guide the design of targets over a wide range of parameters including those for NDCX-II and the proposed BELLA-i.
1. J. Schwartz, et al, J. Appl. Phys. (2014). 2. P. Seidl, et. al. NIM A **800**, 98 A (2015); J. J. Barnard, et al., NIM A **733**, 45 (2014). 3. M.M. Marinak, et al Phys. Plasmas **8** 2275 (2001). *This work was performed under the auspices of the U.S. DOE under contracts DE-AC52-07NA27344 (LLNL), DE-AC02-05CH11231 (LBNL) and was supported by the US DOE Office of Science, Fusion Energy Sciences. LLNL-ABS-697271

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