LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

LLNL-TR-652885

Solid Radiochemistry Nuclear Diagnostic Results from Exploding Pusher Shot (N130503-002) at the National Ignition Facility

N. Gharibyan, K. J. Moody, P. M. Grant, D. A. Shaughnessy

April 10, 2014

Disclaimer

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Solid Radiochemistry Nuclear Diagnostic Results from Exploding Pusher Shot (N130503-002) at the National Ignition Facility

Narek Gharibyan, Ken Moody, Pat Grant and Dawn Shaughnessy

The Solid Radiochemistry (SRC) nuclear diagnostic platform has been developed for the assessment of various performance parameters, such as areal fuel density and ablator-fuel mixing, associated with the capsule implosion of DT-fuel, hohlraum based shots at the National Ignition Facility (NIF). This diagnostic is based on the collection and characterization of debris from the capsule and surrounding materials (primarily gold from the hohlraum). SRC utilizes two diagnostic instrument manipulators (DIMs), 90-78 and 0-0, to field debris collectors (maximum of four metallic and/or graphite foils per DIM) inside the NIF chamber during shots. The debris collectors are removed after a shot and transferred to the Nuclear Counting Facility (NCF) for the measurement of gold activation (Au-196m and Au-196) and capture (Au-198) products via gamma spectroscopy [1]. The results from SRC which show a strong dependency on an independently measured neutron down scatter ratio (DSR) are utilized as part of a 1-D capsule model to determine the areal densities (ρR(DT) and ρR(CH)) during burn [2]. This report summarizes the SRC results from the Indirect Drive Exploding Pusher shot (N130503-002) [3] designed to produce low ρR at burn time ($\sim$40 mg/cm^2) leading to a significant decrease in DSR (0.23$\pm$0.07 %). As a result, this shot is considered a calibration shot for SRC nuclear diagnostic.

A total of seven SRC collectors were fielded on this shot: graphite (90-78 pos1, 0-0 pos3 and pos4), tantalum (90-78 pos3 and 0-0 pos2) and vanadium (90-78 pos4 and 0-0 pos1). Based on the initial gamma spectroscopy results, all graphite collectors were discarded due to poor debris collection in order to maximize counting time on the other collectors. The metallic collectors on 0-0 DIM had lower collection efficiency of gold in comparison to those on 90-78 DIM. Consequently, Au-198 was not observed on both collectors from 0-0 DIM. The results are summarized in Table 1 (pg. 2). The average value per DIM is the weighted average of all the measurements from that DIM based on statistical uncertainties. The systematic uncertainties are only taken into account in the total uncertainty as reported in the results.

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

1. Shaughnessy, D.A., *et. al.*, submitted to Rev. Sci. Instrum. (2013)
2. Hagmann, C., *et. al.*, to be submitted to Phys. Plasmas (2014)
3. Lepape, S., *et. al.*, IFSA 2013 proceedings, Nara, Japan, Sep 9-13 (2013)

Table 1: Summary of SRC results from N130503-002. The systematic uncertainties associated with these measurements are 1.06 % and 3.99 % for ^{198t}Au/^{196g}Au and ^{196m}Au/^{196g}Au atom ratios, respectively. The statistical uncertainties are indicated in parentheses.

DIM	Position	Collector Material	^{198t}Au/^{196g}Au Atom Ratio	Uncertainty Percent	^{196m}Au/^{196g}Au Atom Ratio	Uncertainty Percent
90-78	3	Tantalum	$9.562 * 10^{-4}$	10.7 (10.7)	$7.135 * 10^{-2}$	4.11 (1.00)
90-78	4	Vanadium	$9.859 * 10^{-4}$	8.85 (8.79)	$6.934 * 10^{-2}$	4.10 (0.92)
90-78	Average		$9.735 * 10^{-4}$	6.87 (6.79)	$7.023 * 10^{-2}$	4.05 (0.68)
0-0	1	Vanadium			$7.192 * 10^{-2}$	6.00 (4.48)
0-0	2	Tantalum			$7.021 * 10^{-2}$	4.53 (2.14)
0-0	Average				$7.052 * 10^{-2}$	4.43 (1.93)