

LA-UR-17-26889

Approved for public release; distribution is unlimited.

Title: Auger Spectroscopy Analysis of Spalled LEU-10Mo Foils

Author(s): Lawrence, Samantha Kay
Schulze, Roland K.

Intended for: Programmatic

Issued: 2017-08-03

Disclaimer:

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the Los Alamos National Security, LLC for the National Nuclear Security Administration of the U.S. Department of Energy under contract DE-AC52-06NA25396. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

Auger Spectroscopy Analysis of Spalled LEU-10Mo Foils

Roland K. Schulze
Samantha K. Lawrence

Sigma Division, LANL

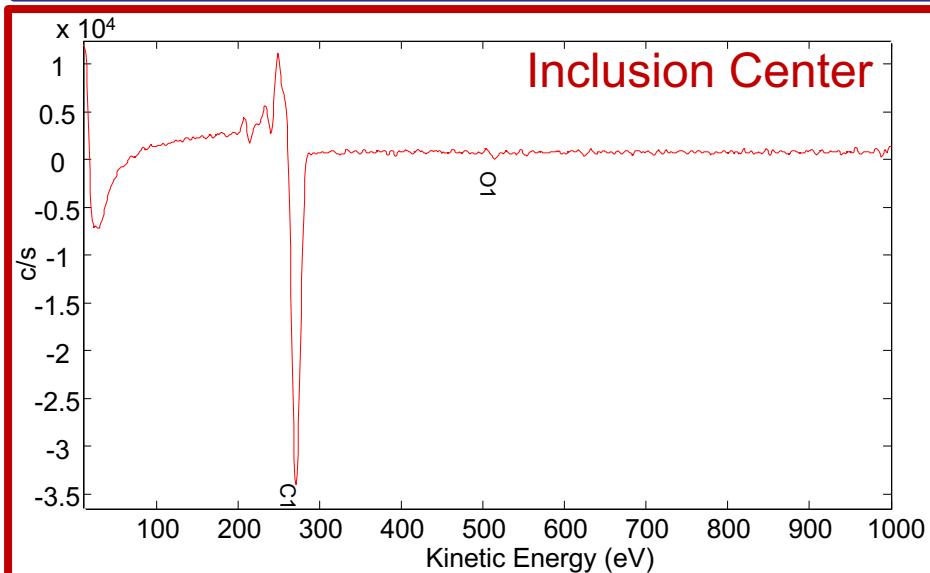
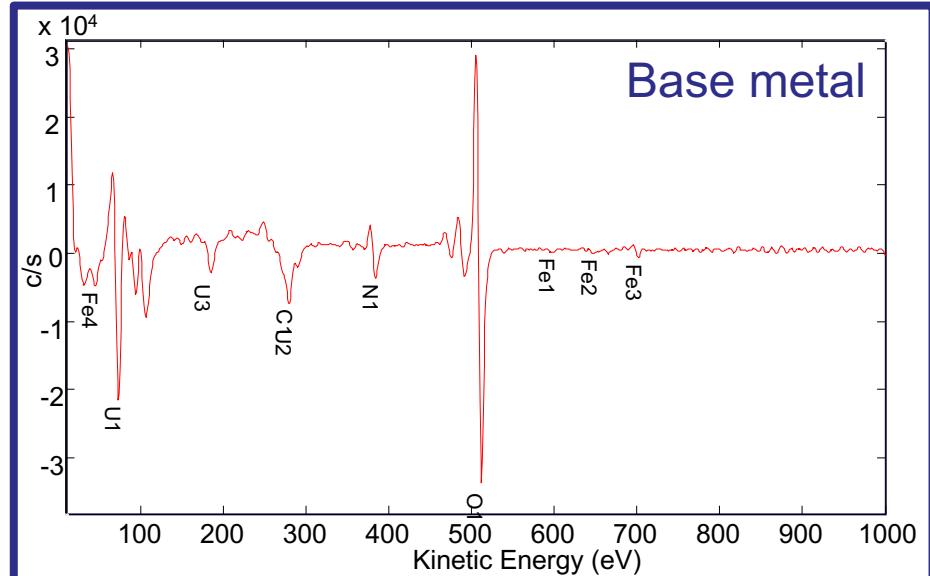
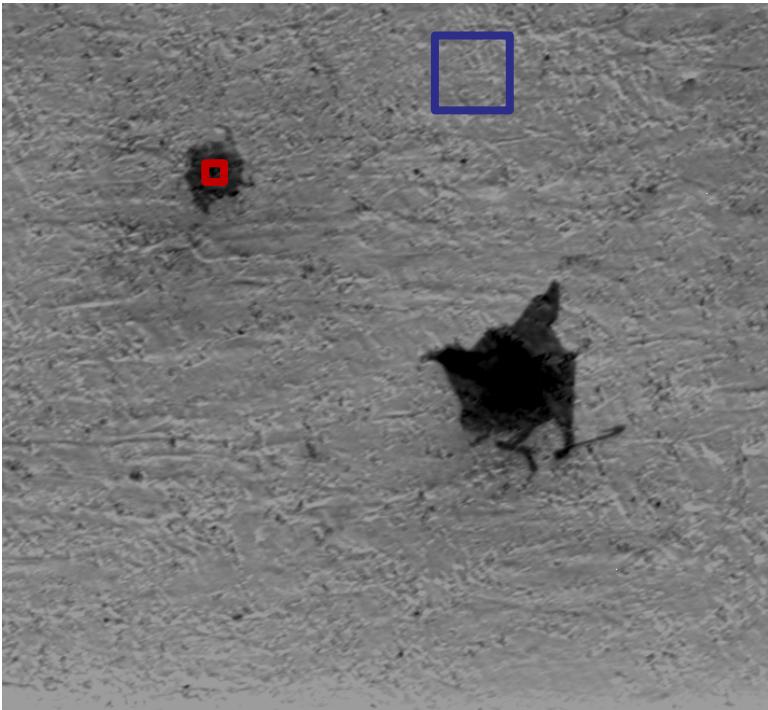
Surface Science used to probe LEU-10Mo Spall



- LANL received uncoated LEU-10Mo foil after rolling at BWXT
- Isolated, but sizable spall defects were observed on the foil
- Preliminary SEM/EDS analysis detected elevated carbon content and some iron inclusions
- Subsequently, Auger spectroscopy employed to attain a higher resolution analysis of chemical composition in an effort to determine origin of spalling

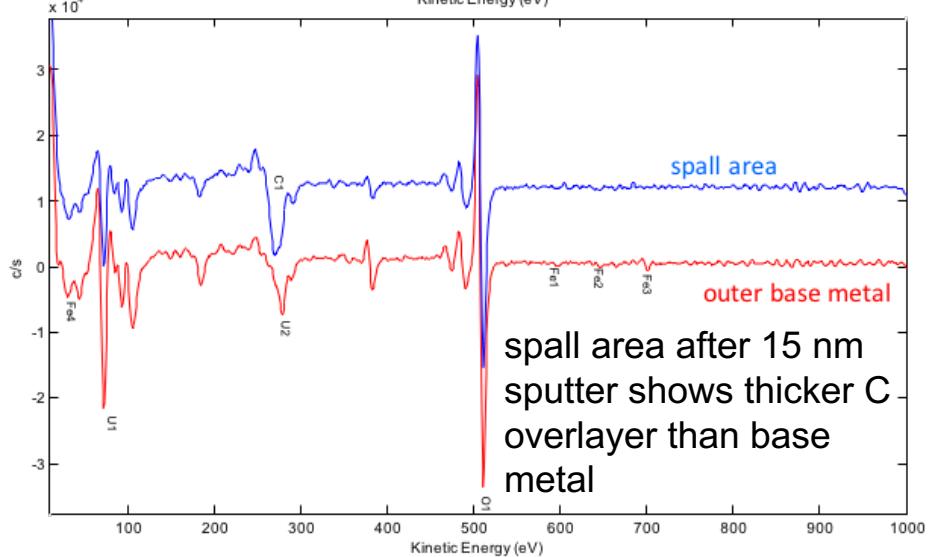
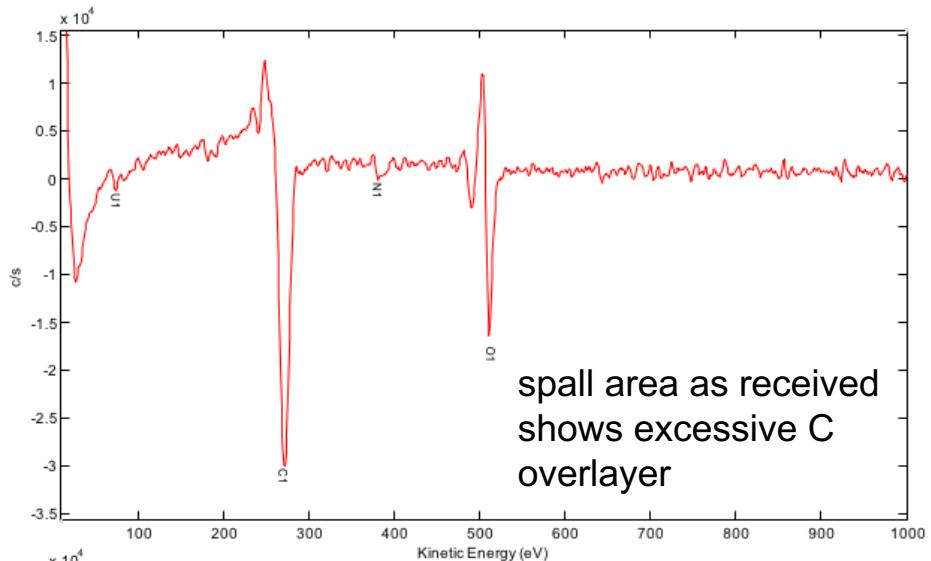
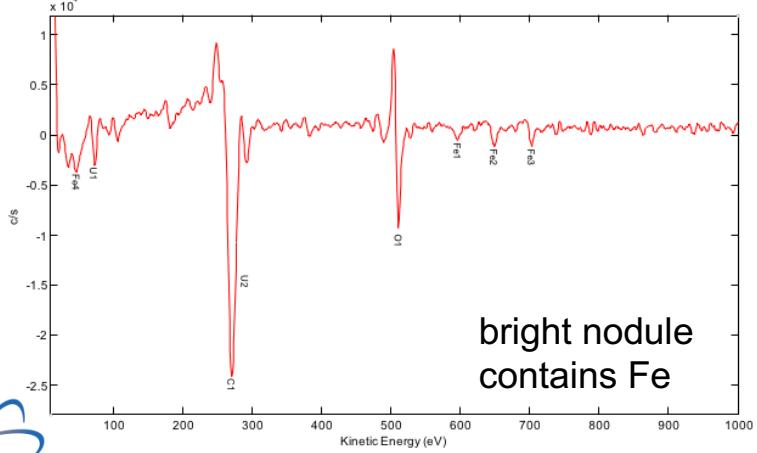
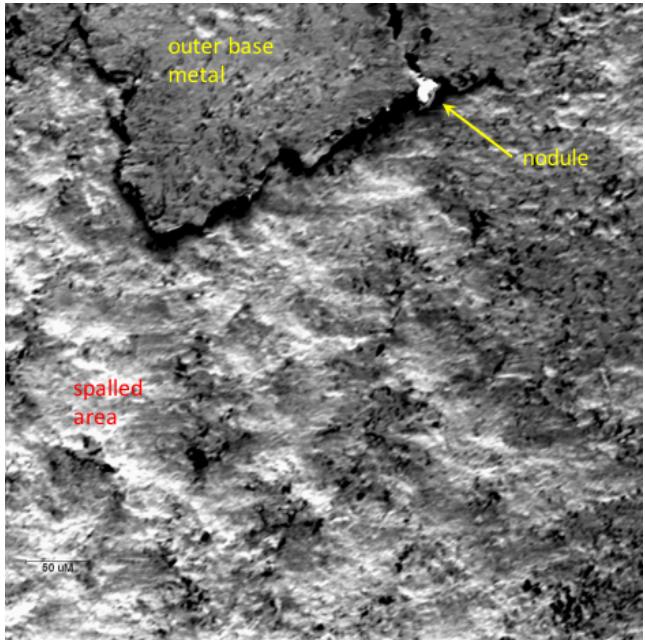


Auger highlights graphitic-like inclusions and Mo-deficient oxide on base metal

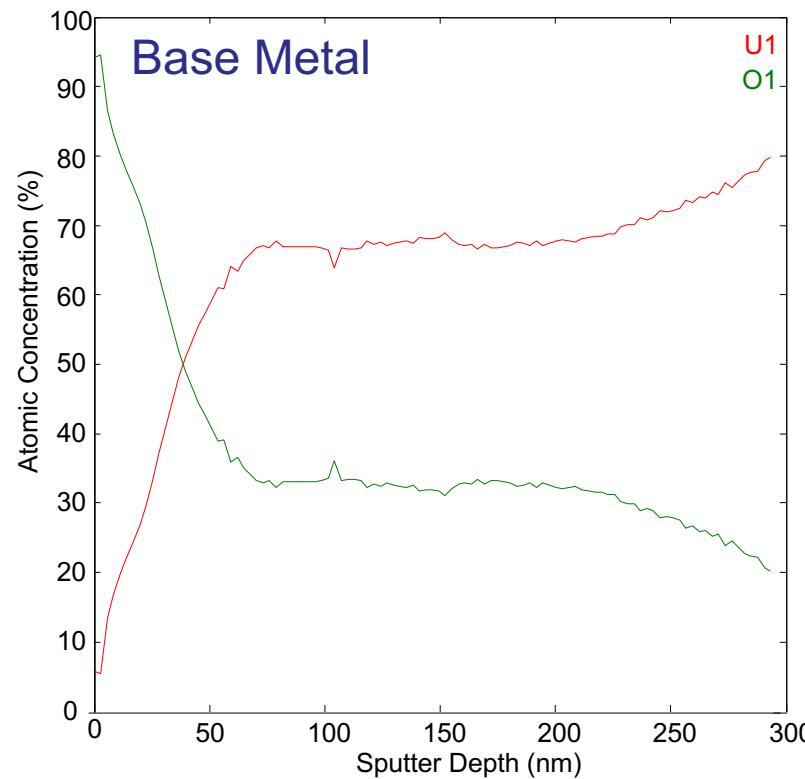


- Oxide film depleted of Mo
- Ion sputtering through oxide film reveals Mo in appropriate concentrations only when clean base metal is reached

Higher C concentration detected within spall area



Depth profiling reveals thick oxide; Mo concentration nears nominal only at depths ~400 nm



- UO_2 layer estimated to be ~37 nm thick by sputter ion etching
- Lower oxygen level (~30% in metal) extends ~460 nm in depth
- Mo only evident after sputtering through the full oxide/ oxygen-enriched metal thickness

Key Findings

- The surface of the base metal shows graphitic-like inclusions (carbon only, not metal carbide), $d = 50-100 \mu\text{m}$.
- The UO_2 oxide layer thickness at the base metal surface is $\sim 37 \text{ nm}$, determined by sputter ion depth profiling; a lower level of oxygen at about 30% atomic (probably dissolved oxygen in metal at a high level) extends into the surface to $\sim 460 \text{ nm}$.
- The surface oxide layer is deficient in Mo; the ratio of Mo:U is much less than 10%, and in fact the Mo may have been fully excluded.
- The higher level of hydrocarbon within the spalled area leads us to believe that, at some point in the processing, there was trapped hydrocarbon at this subsurface location that prevented bonding of adjacent metal leading to delamination (spalling) at this site.