**Introduction**

**Objective:** Develop a technique for accurately and swiftly characterizing special nuclear material (SNM) such as PuGa or other metal-metal alloys to determine age and possible origin.

**Theory:** FCC metals that are capable of producing similar style defects such as dislocation loops and stacking fault tetrahedra (SFT) when subject to irradiation, thus copper is a viable subject for proof of concept testing.

1. Stable isotope fractionation is fundamentally driven by differences in bond strength between anions and cations in crystal structure (Urey, 1947).
2. Bond strength is dominantly influenced by both elemental coordination and the oxidation state of the element in question. Heavier isotopes tend to concentrate in the molecules in which they are present in the highest oxidation state.

**Methods**

**Isotopic Fractionation** is a technique widely used in geological dating. Through isotopic analysis of the oxygen in the CuO and Cu2O layers that form, we can see at approximately what temperatures the metal oxides were formed, and draw conclusions from possible source of oxygen.

**Raman Spectroscopy** provides measurement capable of distinguishing between oxide species (CuO and Cu2O) as the metal ages. This is a field technique that can be used as a “first measure” to readily determine approximate age of material.

**Oxidation States:**

- Atmospheric Oxygen
- Water Vapor
- KOH solution

→ Water vapor and atmospheric oxygen are the most likely sources of oxygen in the oxide layer

**Future Work**

**From this study:**

- Origin from isotopic fractionation of oxygen atoms
- Age from oxidation layer growth and Raman measurements

**Future Studies:** Kinetics to link CuO to uptake of 18O

Controlled environment: adjust for oxygen partial pressure and perform in situ oxidation. If the uptake of oxygen into the copper lattice produces a similar fractionation trend in the controlled experiment, then isotopic analysis of oxygen in metal-metal alloys could be correlated to the age of the material.

**References**