Title: Unanticipated Results in the Uranium Niobium Alloy System

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The uranium niobium binary alloy system exhibits a rich collection of phenomena for study. The composition range from 0wt.% Nb to 10wt.% Nb exhibits multiple crystallographic phases with interesting properties such as superconductivity, charge density waves and shape memory effects. We have measured the resistivity and heat capacity as a function of temperature from 2 to 325K in the above composition range in an effort to map out the phase boundaries of interest. Surprisingly the temperature dependence of the resistivity transitions from metallic (decreasing with decreasing temperature) to nonmetallic (increasing with decreasing temperature). It is not clear if the nonmetallic resistivity is caused by strongly correlated electronic effects or is the result of some other effect such as disorder driven scattering.

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Unanticipated Results in U-Nb Alloys


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Numerous competing phases in the U-Nb system
$\alpha, \alpha'$ uranium (orthorhombic)
\(\gamma_0\) uranium (tetragonal)
\( \gamma \text{ uranium (body-centered cubic)} \)
U-Nb Phase Diagram

Weight Percent Uranium

Weight Percent Uranium

Temperature °C

(Nb,7U)

2469°C

977°C 47.8

850°C

840°C

82.5

98.2

1135°C

Temperature °C

977°C

776°C

868°C

Nb Atomic Percent Uranium

U

NISA

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Resistivity

Temperature (K)

Resistivity (Ω cm)

- U Single Crystal
- U 0.25 wt.%Nb
- U 4.00 wt.%Nb
- U 6.00 wt.%Nb
- U 7.25 wt.%Nb
- U 8.00 wt.%Nb
- U 10.0 wt.%Nb

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Superconductivity

![Graph showing the relationship between $H_{c2}$ and $T$ for different samples.](image)

- **$H_{c2}$ (T)** vs. **$T$ (K)**
- Data points for U6Nb, U8Nb, and U10Nb
- Quadratic Fit curves for each sample
Heat Capacity

![Graph showing the heat capacity versus temperature for different compositions of Nb. The graph plots C_p/T (mJ/K/mol) against Temperature (K). Different symbols represent different compositions: U2wt.%Nb (black circles), U4wt.%Nb (orange squares), U6wt.%Nb (blue triangles), and U8wt.%Nb (green diamonds).]
Normalized resistivity

$\rho(T)/\rho(300K)$ vs Temperature (K)

- $U 0.25$ wt.% Nb
- $U 4.00$ wt.% Nb
- $U 6.00$ wt.% Nb
- $U 8.00$ wt.% Nb
- $U 10.0$ wt.% Nb

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Debye Temperature and $\gamma$

![Graph showing Debye Temperature and $\gamma$ vs. wt.% Nb. The graph displays a decrease in $\gamma$ with increasing wt.% Nb. A line representing Debye Temperature shows an increase with increasing wt.% Nb.](image-url)
Similarity to other alloy systems
