Half-Metallic Antiferromagnets: A New Class of Materials for Spintronic Devices
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**Abstract**
Half-metallic antiferromagnets (HMAF) are a theorized class of materials that would be beneficial for applications in processors for quantum computers and nonvolatile RAM memory devices. HMAF materials can generate a spin-polarized current without generating a disrupting magnetic field. These materials are expected to exhibit antiferromagnetism (AFM) at room temperature, which makes them well positioned for practical devices. In this project, V3Al and Mn3Al were synthesized to investigate their possible HMAF properties. The preliminary data has shown the V3Al displays antiferromagnetic behavior below T_N ~570 K (Neel temperature). The electrical transport measurements show that the compound's carriers are holes and display metallic behavior at room temperature. Current progress on these compounds and other possible HMAF compounds will be presented. The long term outcome of this project would be to find possible materials exhibiting HMAF properties for future electronic memory devices.

**Background: Half-Metallic Antiferromagnets (HMAF)**
- **What are HMAF?**
  - HMAF materials can generate a polarized-spin current with no external magnetic field at room temperature.
- **The Density of States**
  - Normal AFM cannot have a polarized-spin-current.
- **Structural Background**
  - These materials would be ideal for processors for quantum computing and nonvolatile memory.
- **Synthesis Methods**
  - The V3Al samples were grown using arc melting. Arc melting uses a high temperature plasma to weld metallic alloys together in an Argon environment.
  - The MnAl films were grown utilizing Molecular Beam Epitaxy (MBE).
  - MBE uses thermal effusion cells to grow crystalline films in a low pressure environment.

**V3Al Bulk Results:**
- **Structural Measurements**
  - Two like spin states can make another crystal structure apparent in XRD. An AFM spin arrangement generates additional (\(\frac{1}{2}, \frac{1}{2}, \frac{1}{2}\)) or (1.5, 1.5, 1.5) XRD superlattice peaks in a simple cubic structure.
- **Magnetic Measurements**
  - The sample shows a Neel temperature of 590 K, indicating AFM.
  - Low total moment\(\sim 10^{-5}\) \(\mu_B\) per formula unit

**Mn3Al Preliminary Results:**
- **Structural Measurements**
  - The \(D_0^3\) structure is seen with lattice constant 6.144 ± 0.012 Å.
  - The inset shows the (\(\frac{1}{2}, \frac{1}{2}, 0\)) AFM superlattice peak.
- **X-Ray Diffraction Pattern:**
  - The structure is being studied with regards to annealing temperature.
  - The \(D_0^3\) structure peaks are seen.
- **Magnetic Measurements**
  - The signal shows the \(<M^z\) attributed to the Mn moments after sample is annealed between 300-400°C.
  - The signal shows the \(<M^y\) attributed to the Mn moments when sample is annealed at 300°C.

**Conclusion**
- The correct \(D_0^3\) structure was seen via X-ray diffraction.
- Low orbital and spin moments were found.
- More magnetic and transport measurements are needed to prove HMAF properties.

**References**

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