Epitaxizing Untwinned PdCoO$_2$ Films by MBE

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Introduction

**Delafossite—PdCoO$_2$**
- Delafossite materials have a layered triangular structure with chemical formula ABO$_2$.
- PdCoO$_2$ is one of the metallic delafossites with high in-plane conductivity, even higher than pure Pd metal [1].

**Research Question**
Growing by MBE, structural defects contribute to higher resistivity. On Al$_2$O$_3$ (0001) substrates, the crystal structure in each one-monolayer-high step face in a different direction alternately, resulting in PdCoO$_2$ growing on top of them having triangular structures 180º opposite from each other, called "twinning".

To solve twinning, Al$_2$O$_3$ substrates are made to have steps with two-monolayer heights, all facing in the same direction. We hope PdCoO$_2$ grown on top will have triangles in the same direction, thus achieving untwinned films.

**Methods**
Specially treated Al$_2$O$_3$ substrates are provided by our collaborators. We use Molecular Beam Epitaxy (MBE) for absorption control growth, monitored by RHEED. After-growth characterizations include XRR, XRD, φ-scan, and AFM. φ-scan (6 peaks instead of 3 show twinning) and AFM are especially important for twinning analysis.

Results

One specially treated Al$_2$O$_3$ substrate was scanned with AFM before growth. Step height measured was around 0.449 nm, which is two monolayers.

With same growth conditions for regular substrates, impurities appeared (e.g., Pd and CoO). Surface energy of substrate changed. New growth conditions are required.

Conclusion

On two-monolayer step height special Al$_2$O$_3$ substrates:
- Distinguished various impurity phases in AFM images
- Almost achieved pure PdCoO$_2$
- Haven’t solved twinning problem

**Future directions:**
Grow PdCoO$_2$ on untwinned CuCrO$_3$ buffer layer to solve twinning problem. See hope as we have successfully grown untwinned CuCrO$_3$ films.

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References