Improving qubit coherence time through detailed materials analysis

Cristy M. Rosado Bonilla,1 Malvika Tripathi,2 Akshay Murthy2
1University of Puerto Rico Mayagüez, 2Fermi National Accelerator Laboratory

INTRODUCTION

In the technological landscape of today, quantum computing represents a frontier comparable to the space race of our generation. Central to the development of quantum computers are superconducting materials, which exhibit almost zero electrical resistance at low temperatures. These materials hold immense promise for qubits due to their potential to improve coherence times, which refers to the duration over which quantum information remains accurately preserved in a quantum state.

This project aims to investigate defects, imperfections, and variations in deposited thin films of Nb. To achieve this, characterization techniques such as Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS), and X-Ray Photoelectron Spectroscopy (XPS) are used to meticulously analyze the homogeneity of Nb thin films. This research contributes to the development of more reliable and efficient quantum computing technologies, addressing fundamental challenges and paving the way for future advancements in this rapidly evolving field.

METHODS

W114 (DC Magnetron Sputtering)

W118 (Electron Cyclotron Resonance)

RESULTS

<table>
<thead>
<tr>
<th>SPOT 1</th>
<th>W114</th>
<th>W118</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb₂O₅</td>
<td>3d5/2</td>
<td>207.2</td>
</tr>
<tr>
<td>Nb 3d5/2</td>
<td>202.2</td>
<td>23.2</td>
</tr>
<tr>
<td>NbO 3d5/2</td>
<td>204.3</td>
<td>2.8</td>
</tr>
<tr>
<td>NbO₂ 3d5/2</td>
<td>205.9</td>
<td>6.5</td>
</tr>
</tbody>
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OBSERVATIONS AND CONCLUSIONS

- SEM: Observed presence of small, distinct structures in W114. Surface morphology is visibly uniform in W118.
- EDS: The elemental composition is uniform across the films. There is a higher signal for aluminum in sample W118 compared to sample W114, attributed to the thickness difference between the samples.
- XPS: There is a higher Nb₂O₅ signal detected in W118 compared to W114, which is due to a thicker oxygen layer in sample W118.

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