Metallographic Polishing of bulk Niobium QPR (HZB) and planar Cu samples (STFC)

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Recall from the 5th iFAST WP9 meeting
QPR – A5 (HZB)
<table>
<thead>
<tr>
<th>Surface processing</th>
<th>Sample History</th>
<th>RF Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. BCP removal of 150 µm at RI</td>
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<tr>
<td>2. 800 °C annealing, 4 hours</td>
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<tr>
<td>3. BCP removal of 10 µm at RI</td>
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<td></td>
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<tr>
<td>4. MP removal of 250 µm (2 steps) at IJCLab</td>
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<tr>
<td>1. RCD + 3 um dia</td>
<td></td>
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<tr>
<td>2. Polyurethane disk + 50 nm SiO2</td>
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**Improvised roughness**

**Bad RF performance**

**Metallographic polishing led to hydrogen loading and Q-disease**
Summary QPR – A5

Surface processing

Sample History
1. BCP removal of 150 µm at RI
2. 800 °C annealing, 4 hours
3. BCP removal of 10 µm at RI
4. MP removal of 250 µm (2 steps) at IJCLab
   1. RCD + 3 um dia
   2. Polyurethane disk + 50 nm SiO2

Reset of the sample

Sample History
1. 50 µm EP at CEA (T. Proslier)
2. 800 °C for 3 h at IJCLAB
3. 25 µm EP at CEA (F. Eozenou)

RF Test

Improved roughness
Bad RF performance

Lowest $R_{\text{res}}$ measured so far at HZB (4.1 nOhms at 414 MHz, 9.7 nOhms at 846 MHz) #run 37

MP has to be followed up with heat treatment to prevent Q-disease

Improved roughness

Bad RF performance

Metallographic polishing led to hydrogen loading and Q-disease

Lowest $R_{\text{res}}$ measured so far at HZB (4.1 nOhms at 414 MHz, 9.7 nOhms at 846 MHz) #run 37

MP has to be followed up with heat treatment to prevent Q-disease
MP treatment of the new bulk Niobium QPR sample
New bulk Nb QPR sample for RF test at HZB

Initial – EP polished

MP polished

Step 1

Step 2 (30 min)

Step 2 (500 min)

Recipe

**Step 1:** Rigid composite disk + 3µm polycrystalline diamond
*Time:* Until plane – 30 min
*Removal layer:* 20 um

**Step 2:** Microporous polyurethane cloth + a 50-nm silica colloidal abrasive diluted in water (20%)
*Time:* Until removed embedded diamonds – 500 min
*Removal layer:* 3 um

Current status & Future plans

- Bulk Nb QPR sample has been metallographically polished at IJCLAB (23 um removed)
- Perform heat treatment at 800 °C for 3 hours at IJCLAB
- Test metallographically polished QPR at HZB
MP treatment of the Cu planar samples (two different designs) for multilayer activities at STFC
Recipe for Cu planar samples

<table>
<thead>
<tr>
<th>Step</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk</td>
<td>Resine</td>
<td>Resine</td>
<td>Resine + Cu powder (RCD)</td>
<td>Woven wool fibres</td>
<td>Viscose fibres</td>
</tr>
<tr>
<td>Abrasive / Size, μm</td>
<td>diamonds 125 um (embedded in disk)</td>
<td>diamonds 15 um (embedded in disk)</td>
<td>diamonds 3 um (slurry)</td>
<td>diamonds 3 um (slurry)</td>
<td>diamonds 1 um (slurry)</td>
</tr>
<tr>
<td>Dosing frequency (ON/OFF)</td>
<td>1 sec/15 sec (lubricant)</td>
<td>1.5 sec/15 sec (lubricant)</td>
<td>1 sec/25 sec</td>
<td>1 sec/15 sec</td>
<td>1 sec/15 sec</td>
</tr>
<tr>
<td>Applied force, N (d = 110 mm)</td>
<td>200</td>
<td>250</td>
<td>250-200</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Rotation speed disk/sample, RPM</td>
<td>150/150</td>
<td>150/150</td>
<td>150/150</td>
<td>60/150</td>
<td>60/150</td>
</tr>
<tr>
<td>Direction disk/holder</td>
<td>Complementary</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration, min</td>
<td>Until plane = 4 min</td>
<td>15 min</td>
<td>15 min</td>
<td>40 min</td>
<td>10 min</td>
</tr>
</tbody>
</table>

Sample Holder

Planar RF sample

After MP processing

d = 100 mm

d = 110 mm

Courtesy of Daniel Seal
Cu planar samples

Current status & Future plans

- 4 Cu planar samples (2 designs) have been metallographically polished at IJCLAB (130-140 um removed)
- Perform RF comparison of MP Cu substrates compared to diamond-turned Cu substrates (commissioned at STFC)
- Reduce of abrasive size to ¼ um potentially will lead to reduced roughness (at 1 um used -> Sa=20 nm measured for the area of 1 mm2)
Thank you for your attention

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