Target Characterisation by PIXE, Alpha Spectrometry and X-ray Fluorescence Spectrometer

Ntombi Y. Kheswa

Scope

• Introduction
• Zr-96 manufacturing
• Characterisation of $^{96}$Zr

INTDS 2010
Introduction

Purpose

- Benchmark target thickness measurement unit
- In order to determine performance and accuracy

Characterisation methods

- Alpha source
- PIXE
- X-ray absorption

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Preparation of Zr-96

Target prep. Method: rolling of Zr-96

Targets thicknesses in mg·cm^-2:

• 0.85
• 2.0
• 17.0
Characterisation methods used on Zr-96

Alpha spectrometry

• Newly designed and built in – house

Description of the measurement unit

• Surface Barrier Silicon detector -500 um thick
• Spectra recorded- Pocket MCA (ATOMKI Debren)
• 228Th-source with energy transitions-5.4-8.7844 MeV
• Transmission spectra are analysed-ROOT software
• The energy loss calculation is based on Ziegler tables
• Uncertainty- 2% (depends upon centroid determination of peaks)
Picture of thickness measurement unit
Analysis by PIXE

- Conducted at Microprobe analysis facility MRD at iThemba LABS
- Targets were bombarded proton beam
  Energy-3MeV
  \( I = 50-100 \text{pnA} \)
  Sport size-3um
- Data collection - XSYS acquisition system was processed by GeoPIXE II

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Analysis by X-ray Fluorescence Spectrometer

- Conducted for elemental characterisation and thickness measurement at SU
- Thickness measured based on the equation:
  \[ X = -\log \left( \frac{I}{I_0} \right) \mu \]
  - \( I_0 \): incoming flux
  - \( I \): transmitted X-rays
  - \( \mu \): absorption coefficient
  - X-rays generated from – 40 kV electron tube + 7mm\(^2\) Si drift detector. (140 eV)
## Results

Table of results illustrating thicknesses obtained in mg.cm$^{-2}$

<table>
<thead>
<tr>
<th>Wt/area</th>
<th>PIXE</th>
<th>X-ray absorption</th>
<th>Alpha Spectrometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.85</td>
<td>0.81</td>
<td>0.97</td>
<td>0.94</td>
</tr>
<tr>
<td>2.0</td>
<td>2.1</td>
<td>2.18</td>
<td>2.01</td>
</tr>
<tr>
<td>17.0</td>
<td>18.0</td>
<td>17.27</td>
<td>16.58</td>
</tr>
</tbody>
</table>
Mapping image obtained from PIXE analysis
Discussion

- Results for 2 mg.cm$^{-2}$ target were consistent – four methods
- Discrepancy (15%) between PIXE, X-ray & alpha-for a thinner target.
- Roughness not measured - believed to be accounted for deviation.
- Thicker target - relatively good agreement - difference of 8%.
Aknowledgements

• iThemba LABS mechanical engineering workshop
• iThemba LABS
• INTDS