SPUTTER DEPOSITION OF DIELECTRIC FILMS FOR HIGH TEMPERATURE SENSOR APPLICATIONS

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INTRODUCTION

• high breakdown field strength,
• high insulation resistivity,
• high area yield,
• high piezoelectric coefficient,
• resistance to aggressive media,
• effective permeation barriers,
• good adaptation of the coefficients of expansion to the substrate
• temperature stability
  • 200°C for application in process control for injection molding
  • 400°C measurements in the combustion chamber
  • 600°C measurements in the exhaust line of combustion engines
  • 800°C for turbine applications

DEPOSITION TECHNOLOGY

• Double Ring Magnetron DRM 400
• film thickness uniformity: up to ±0.5% on 8” substrate by stationary coating
• reactive sputtering from metallic target using closed loop reactive gas control
• high rate deposition of AlN, AlScN films, measured at room temperature on silicon wafer, film thickness 8 µm
• deposition rate of dielectric films 80 ... 250 nm/min

PIEZOELECTRIC AlN AND AlScN FILMS

• high piezoelectric coefficient of AlN
• good insulation strength also at an operation temperature of 400°C
• double ring magnetron DRM 400 for uniform coating of Ø 200 mm (8”) substrates

ELECTRICALLY INSULATING Al2O3, SiO2 AND Si3N4 FILMS

<table>
<thead>
<tr>
<th>Material</th>
<th>Deposition rate [nm/min]</th>
<th>Resistivity [Ω cm]</th>
<th>Breakdown field strength [MV/cm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO2</td>
<td>250</td>
<td>6,3 × 10¹⁴</td>
<td>5.6</td>
</tr>
<tr>
<td>Al2O3</td>
<td>150</td>
<td>2,3 × 10¹⁴</td>
<td>6.2</td>
</tr>
<tr>
<td>Si3N4</td>
<td>80</td>
<td>5,2 × 10¹⁴</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Applications of insulating films

• insulation between metallic sensor body and measurement application
• example: electrical separation between metallic membrane and resistive structure in pressure sensors

SUMMARY

• high rate deposition of AlN, Al2O3, Si3N4 and SiO2 films
• good insulation strength also at an operation temperature of 400°C
• high piezoelectric coefficient of AlN
• improvement of thermal stability of Al2O3 by 5% SiO2 content
• high permeation barrier of the films

APPLICATIONS OF PIEZOELECTRIC AIN FILMS

• energy harvesting
• ultrasonic microscopy with phased array sensors
• pipe surveillance
• BAW components
• temperature stability 1100°C

APPLICATIONS OF INSULATING FILMS

• effective permeation barriers,
• resistance to aggressive media,
• high insulation resistivity,
• high breakdown field strength,
• good adaptation of the coefficients of expansion to the substrate

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