Silicon carbide is intended for use in the breeding blanket of future fusion reactors due to its corrosion resistance, high temperature strength, low thermal expansion, good thermal conductivity, and low nuclear activation.

RB-SiC is simple to make in the required shapes, but radiation resistance needs to be improved due to differential radiation-induced swelling between silicon and SiC.

Silicide reaction-bonded SiC

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Composition</th>
<th>Time</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>RB-SiC with Si-13.2at% Cr</td>
<td>1500°C, 30 minutes</td>
<td>19.4% CrSi₂ 80.3% SiC</td>
<td>1.5 mm partial infiltration into 4mm thick bodies, ~0.3% residual porosity. No silicon.</td>
</tr>
<tr>
<td>RB-SiC with Si-4.4at% W</td>
<td>1700°C, 10 minutes</td>
<td>3.5% WSi₂ 9.0% Si 87.0% SiC</td>
<td>4 mm thick bodies fully infiltrated, ~0.5% residual porosity.</td>
</tr>
</tbody>
</table>

Conclusions and future work

- Silicon can be completely removed from RB-SiC and replaced with a silicide via eutectic alloy reactive melt infiltration
- 3D structure shows isolated silicide regions - good SiC connectivity
  - Further optimisation to improve infiltration depth and reduce silicon
  - Ion implantation and micromechanical testing to investigate radiation-induced strains and thermal conductivity degradation

Processing with Si-alloys

To improve radiation resistance, reducing silicon content is important. Silicon alloys were made by arc melting silicon with chromium, or tungsten, at near-eutectic compositions. These were melt infiltrated into SiC/carbon black porous preforms in vacuum. Si + C → SiC, plus residual silicide.

Silicon contrast is not visible due to overwhelming tungsten contrast.

References & Acknowledgements

3. Davies, R.H. et al., 2002. MTDATA-thermodynamic and phase equilibrium software from the national physical laboratory. Calphad, 26, pp.229-71

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