Advances in the chemical vapor deposition (CVD) of Tantalum

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Publication date: 2014

Citation (APA):
CHEMICAL VAPOUR DEPOSITION (CVD) OF TANTALUM

- In Long narrow channels

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Why Tantalum?

**Percentage Weight loss in 10 wt % HCl, room temperature, α-alumina abrasives and 1000 rpm for 168 hours.**

Tantalum Coated Plate Heat Exchanger
SYSTEM DESCRIPTION

Ta\textsubscript{(s)} + 2.5Cl\textsubscript{2(g)} \rightarrow TaCl\textsubscript{5}

TaCl\textsubscript{5} + \frac{5}{2}H\textsubscript{2} \rightarrow Ta + 5HCl
Modeling

Long narrow Channel: Tubes

Fluid Flow: Navier Stokes

Diffusion: Fick’s Law

Chemical Reaction: Arrhenius

Adsorption: Langmuir
Results:

Experiment 800°C, 25 mbar

- Tantalum Thickness [µm/h]
- Position in tube [m]
Experiment 850°C, 25 mbar

![Graph showing Tantalum Deposition Rate vs Position in tube]
Experiment 900°C, 25 mbar

Tantalum Deposition Rate [µm/h] vs. Position in tube [m]

- **Try 1**
- **Try 3**
- **Try 4**
Experiment 950°C, 25 mbar

Tantalum Deposition rate [µm/h]

Position in tube [m]

Try 1

Try 2
All Temperatures, 25 mbar

![Graph showing the deposition rate of tantalum at different temperatures. The x-axis represents the position in the tube (m), and the y-axis represents the deposition rate (µm/h). The curves are labeled for temperatures of 800 C, 850 C, 950 C, and 900 C x 4.]
All Pressures, 800 °C

- 25 mbar -- 50g Cl₂/ h
- 100 mbar -- 50g Cl₂/ h
- 300 mbar -- 30g Cl₂/ h
- 1 atm -- 30g Cl₂/ h

Tantalum Layer Deposition Rate [µm/h]

Position in the Tube [m]
Model Fitting
Model

Fluid Flow: Navier Stokes

Diffusion: Fick’s Law

Adsorption: Langmuir

Chemical Reaction: Arrhenius

Geometry: 2D Axial Symmetry and 3D

Software: COMSOL MultiPhysics®
Mechanism

**Gas Phase Reaction**

\[ TaCl_5(g) + \frac{1}{2}H_2 \rightarrow TaCl_4(g) + \frac{1}{2}H_2 \]

**Surface Reaction**

\[ Ta(s) + 4HCl(g) \rightarrow TaCl_3(g) + 3HCl(g) \]
Model Fitting – 800 °C

Tantalum Deposition Rate um/h vs Position in tube [m]
Model Fitting – 850 °C

![Graph showing tantalum deposition rate vs position in tube at 850 °C. The graph plots deposition rate in um/h on the y-axis against position in tube in meters on the x-axis. The deposition rate peaks sharply near the beginning of the tube and gradually decreases as the position increases.]
Model Fitting – 900 °C

Tantalum Deposition Rate um/h

Position in tube [m]
Model Fitting – 950 °C

Graph showing Tantalum Deposition Rate um/h vs Position in tube [m].
Application
CB30 – Channel
CB30 – Channel (X-Y Plane)
CB30 – Streamline: Velocity field Visualization
CB30 – Streamline: Velocity field Visualization
CB30 – 1st Run: Tantalum Layer Thickness (i.e. Only treated from the right end)
CB30 – 1st Run: Tantalum Layer Thickness
(i.e. Only treated from the left end)
CB30 – 2\textsuperscript{nd} Run: Tantalum Layer Thickness (i.e. Treated from the both ends)
CB30 – 2\textsuperscript{nd} Run: Tantalum Layer Thickness
(i.e. Treated from the both ends)
Thank you for your attention.