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**

\[ Ta_{(s)} + 2.5Cl_2_{(g)} \rightarrow TaCl_5 \]

\[ TaCl_5 + \frac{5}{2}H_2 \rightarrow Ta + 5HCl \]
Modeling

Long narrow Channel: Tubes

Fluid Flow: Navier Stokes

Diffusion: Fick’s Law

Chemical Reaction: Arrhenius

Adsorption: Langmuir
Results:

Experiment 800°C, 25 mbar

![Graph showing tantalum thickness vs. position in tube for different tries.]

- **Tantalum Thickness [µm/h]**
- **Position in tube [m]**

- **Try 1**
- **Try 2**
Experiment 850°C, 25 mbar

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

- Try 1
- Try 2
- Try 3
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

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

- 800 C
- 850 C
- 950 C
- 900 C × 4
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

\[ TaCl_5(g) + \frac{1}{2}H_2 \rightarrow TaCl_4(g) \rightarrow TaCl_3(g) \]

Adsorption

\[ Ta(s) + 4HCl(g) \]

Gas Phase Reaction

Adsorption

\[ Ta(s) + 3HCl(g) \]

Surface Reaction

\[ + HCl(g) \]

\[ + HCl(g) \]

\[ + HCl(g) \]
Model Fitting – 800 °C

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

Position in tube [m]

Tantalum Deposition Rate um/h
Model Fitting – 850 °C

![Graph showing Tantalum Deposition Rate (um/h) vs Position in tube (m) at 850 °C]
Model Fitting – 900 °C

![Graph showing Tantalum Deposition Rate um/h vs Position in tube [m]]

- Tantalum Deposition Rate (um/h) vs Position in tube (m)
- The graph illustrates the variation of deposition rate with position in the tube.
- The data points are shown as squares, and the smooth line represents the model fitting for 900 °C.
Model Fitting – 950 °C

Tantalum Deposition Rate um/h

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.