

Constructing self-consistent validated plasma chemistry

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Our products include:



Introduction

This presentation has been developed to disseminate the results of Powerbase project. The overall project aim is to work on a production of power semiconductors based on 300 mm silicon substrates, making them more efficient both in terms of technical capability and cost performance, for various applications. Quantemol is working within a team of industrial and academic partners on the optimisation of the processes used in packaging of GaN devices and developing a GaN pilotline by the end of the project.

This work involves the development of simulation models for these processes: TSV etch (BOSCH process), TSV cleaning and backside silicon tech for diagnostics.

Various tools are modelled on reactor scale level and feature scale level model of the BOSCH process is being developed. Significant part of the work involves the development of plasma chemistry sets used by industrial partners and their validation.

Data Model for chemistry sets

The chemistry sets were assemble using open source data and in house Quantemol library of chemistries.

Example of the chemistry sets used include:

SF_6 ; C_4F_8 ; N_2H_2/O_2 ; $N_2H_2/O_2/CF_4$; $O_2/SF_6/CF_4$; $N_2H_2/SF_6/CF_4$

The chemistry data has been located online at the www.quantemolDB.com web-site and validation details are being compiled and will be available in open access.

The reactions and chemistries are presented in linked tables in a relational database and allow viewer to make searches of the database to retrieve cross section and Arrhenius parameter data with visualization in their browsers.

These sets can become a basis for other plasma chemistry sets assembly and validation.

Conclusions

Industrial processes require notoriously complex gas mixtures which are often not studied in detail in academic settings. As a result it is hard to find any reliable data for modelling. Furthermore, the available data is usually scattered over multiple publications. To simplify the search for the needed data, a centralised database focussing on industrial gases is of advantage.

Quantemol has developed such a database for industrial chemistries, called QDB where Powerbase data sets have been located. Here we demonstrate how a consistent process of research and development can be arranged going from plasma chemistry sets assembly to a feature scale model.

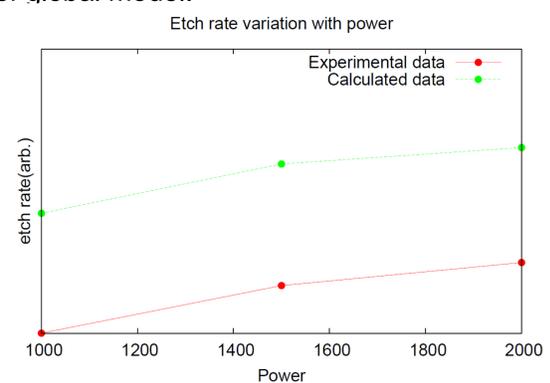
The plasma chemistry database QDB gives free access to data on individual reaction rates and cross sections including those assembled within Powerbase.

Validation: $SF_6/O_2/CF_4$

Published on-line details of the validation are going to include:

- Process conditions used at validation: pressure, power, volume/ surface, flow rates
- Surface chemistry used
- Experimental comparison, i.e. graphs comparing simulation with experiment or another model
- Notes with comments and recommendations (limitations for pressure, what approximations were made etc)

Below is the example of the validation for $SF_6/O_2/CF_4$ comparing experimental results produced by Infineon AG with results of global model.



Etch rate of Si for $SF_6/O_2/CF_4$ at pressure of 400 mTorr.

TSV: SF_6 Etching step

The SF_6 etching as part of the BOSCH (DRIE) process is modelled using output data from a reactor scale model. This process consists of a sequence of polymer deposition and etching steps. The polymer is applied using a plasma deposition in a C_4F_8 environment. A subsequent etching step in SF_6 plasma environment, etched the bottom of the deposited polymer, while the polymer sidewall is protected.

Global_kin[1]
validated
chemistry

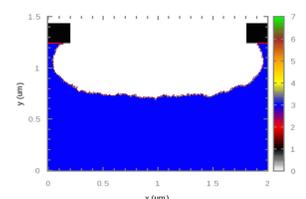
Reactor scale
model in QVT
[2]

Flux distribution of
surface
treating particle

Feature scale model[3]

Output for the first scallop
formation example.

The full model development with
multiple scallops will be developed
at later stages of the project



PowerBase

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