Introduction
This presentation has been developed to disseminate the results of the 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 etch 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
QuantemolDB [1] currently hosts over 17000 data sets on collisional and reactive processes occurring in low-temperature plasmas. You can access Powerbase project related data (SF₆: C₂F₆; N₂H₄/O₂; N₂H₄/O₂/CF₄; O₂/SF₆/CF₄; N₂H₄/SF₆/CF₄) when signing up.

Conclusions
We used the BOSCH process as an example to show the value added by the knowledge of the plasma chemistry and plasma modelling for plasma optimisation. All the chemistry data are located in Quantemol chemistry database (QDB), including electron scattering, heavy particle collisions and surface chemistry reactions. The database is using an elaborate data model to reflect various possible states of the particles and dependencies on temperature and energy.

As a result QDB can be used by plasma modelling researchers in academia and industry to access data they need to work on industrial plasma mixtures and surfaces. This model is used to optimise the TSV etch step in power device manufacturing processes by our partners in Powerbase project: SPTS and ams.

TSV: Bosch Process
As an example of a QDB application the BOSCH process was modelled using output data from the reactor scale model [2,3]. The BOSCH process in this case consists of a sequence of polymer deposition and etching steps. The polymer is applied using a plasma deposition in a C₂H₂ plasma environment. A subsequent etching step in SF₆/O₂ plasma environment etches the bottom of the deposited polymer using an RF-bias of several 100 W to accelerate ions. It is followed by etching in SF₆ plasma, while the polymer sidewall is protected.

The reactor modelled within this work is called Rapier by SPTS. It uses two independently powered coils, one remote (a few 1000 W) and one close to the wafer (some 10 - 100 W). Separate models were developed for each step of the BOSCH process.

Modelling conditions:
- Deposition step in C₂F₆ – medium pressure, no RF-bias
- Polymer removal step in SF₆/O₂ – lowest pressure, RF-bias
- of several 100 W
- Chemical etch step in SF₆ – highest pressure, small RF-bias
- Top power is kept constant at a few 1000 W, secondary power varies around some 100 W.
- For the last step, the secondary power is decreased each cycle. In the simulation, we divided the entire process into 10 subcycles with different powers on the secondary coil.

References