

TPD Workstation

Analysis of Silicon Surfaces by Thermal Desorption

Investigating the microstructure of thin films by thermal effusion measurements

A successful method for investigating the microstructure of thin films by thermal effusion measurements is Temperature Programmed Desorption (TPD), also known as Thermal Desorption Spectrometry (TDS) or Thermal Desorption Analysis (TDA). Analysis by TPD involves positioning the sample in an Ultra High Vacuum (UHV) chamber and heating the sample at different linear temperature ramp rates while collecting the desorption spectra using a quadrupole mass spectrometer. The Hiden TPD Workstation is a complete experimental setup designed for this and many other applications and is optimised to obtain maximum sensitivity for desorption species ranged from 1 – 300 amu.

Optimisation of Sensitivity

The Hiden TPD workstation has several features to optimise the sensitivity of the system for low level desorption products. These include:

- ▶ No sample holder – only the sample enters the UHV chamber meaning no outgassing components other than the sample.
- ▶ High sensitivity triple filter PIC quadrupole mass spectrometer.
- ▶ Close coupling between the sample and mass spectrometer for maximum sensitivity and optimum desorption profile.
- ▶ Cooled mass spectrometer shroud to minimise background contributions.

Silicon Surface Analysis

In this example a Si wafer coated with Al_2O_3 was heated at a constant rate of $30\text{ }^\circ\text{C}/\text{min}$ to $1000\text{ }^\circ\text{C}$. During the temperature ramping, a 1-50 amu bar scan was performed to detect the desorbing species. The complete mass range analysed is depicted in the 3D plot below.

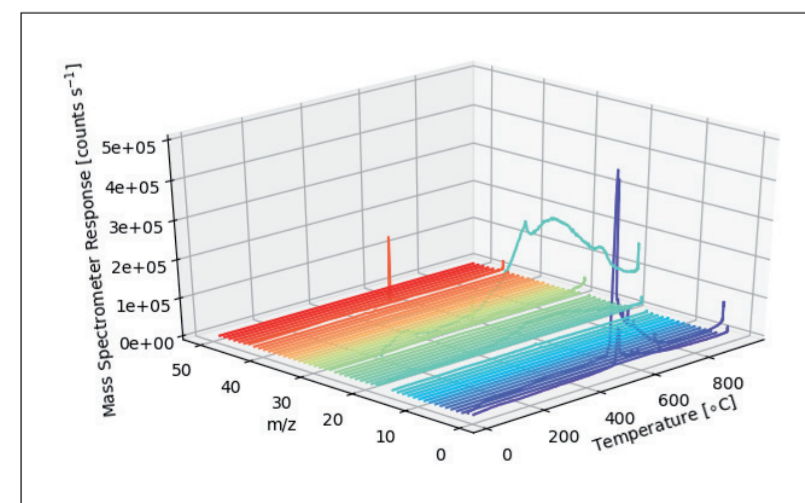


FIGURE 1 : 3D Bar scan plot, m/z 1-50

The main desorbing species observed, namely m/z 1 – H, 2 – H_2 , 17 – HO, 18 – H_2O , 28 – CO, 44 – CO_2 , are shown in the plot below which is derived from the 1 – 50 amu bar scan data (3D plot).

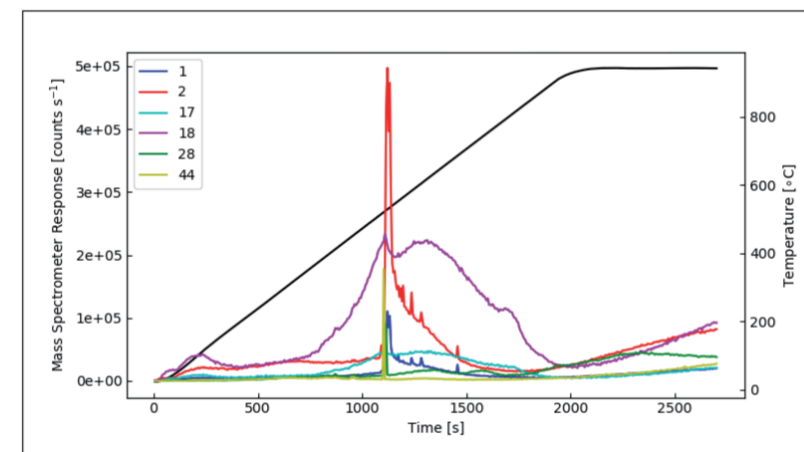


FIGURE 2 : MID plot of highest intensity desorption species

High Resolution Analysis

In a second TPD run with a fresh sample of the same material, the desorbing species of interest, here H_2 , H_2O and CO_2 water and carbon dioxide, were measured again with a multiple ion detection (MID) scan which yields a higher time, i.e. temperature resolution for the desorbed species of interest. The result is shown in the plot below.

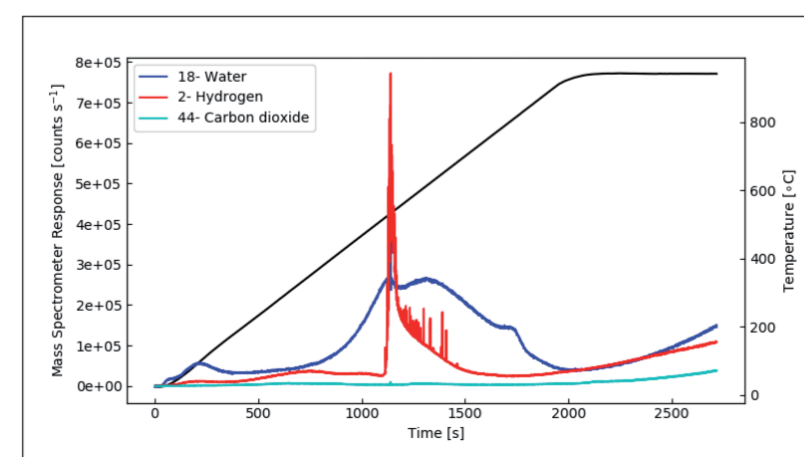


FIGURE 3 : High Acquisition speed MID plot of H_2 , H_2O and CO_2

As expected, the MID scan results are in agreement with the spectra obtained from the 1 – 50 amu bar scan. Noticeably, the data for hydrogen show several spikes at temperatures above $500\text{ }^\circ\text{C}$ which probably occur from blistering of the sample surface giving rise to a sharp evolution of gas.

Surface Sample Comparison

To demonstrate the differences in these effusion measurements to other samples, the plot shows data acquired from a similar Al_2O_3 coated Si sample produced at a different deposition temperature. Here, the CO_2 and H_2O signal behave similarly to the first sample, but almost no H_2 desorption is observed.

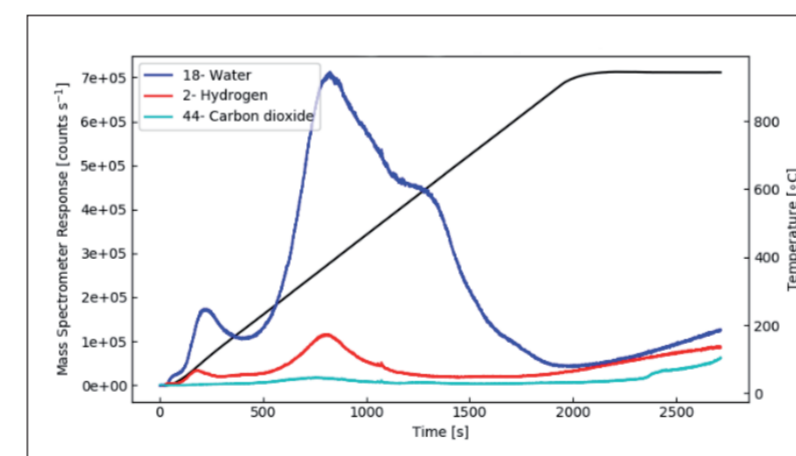


FIGURE 4 : MID plot from different Si/ Al_2O_3 sample

Conclusions

The Hiden TPD Workstation is ideal for examining the microstructure of differently coated silicon surfaces and other thin film materials. Additionally, any other gases can be detected simultaneously with the species of interest. The Hiden TPD Workstation is easy to use and offers high sensitivity and repeatability.



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