

› **CONTAMINATION EXPERIMENT**
D006 2023FPL/INK 29 | R.P. EBELING

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› BACKGROUND

- › If volatile hydrocarbons are present in the SEM vacuum chamber, these hydrocarbons can adsorb onto the sample surface.
- › When the SEM electron beam then interacts with the hydrocarbons on the sample surface, the hydrocarbons decompose, resulting in carbon deposits.
- › Depending on the amount of volatile hydrocarbons, electron beam parameters (electron energy, current, dwell time, etc.) and sample surface properties, the carbon deposits can reach thicknesses in the order of several nanometers.
- › The presence of volatile hydrocarbons in the SEM vacuum can originate from:
 - › Outgassing from the sample
 - › This can occur for example when a sample is not very clean when it is loaded into the SEM.
 - › Outgassing from the SEM vacuum chamber
 - › This can occur when contaminated samples have been in the vacuum chamber, subsequently contaminating the walls and sample holder.
 - › In addition, hydrocarbons can also be introduced into the vacuum chamber from other sources, such as the SEM filament, lubricants, or other materials used in the instrument.

› CARBON CONTAMINATION TEST

- › A test is proposed to assess if the SEM itself is not a source of carbon deposition on samples.
- › This is tested by analysing a well defined area on a standard sample with pre-defined settings, for a defined amount of time.
- › After the analysis is performed, the data are processed and carbon amounts are quantified.
- › The amount of quantified carbon should be less than the requirement value.
- › Details of the test are elaborated in the following slides.

› TEST DETAILS (1)

- › One standard 2" Si wafer is used for the test.
- › The wafer should be cleaned (e.g. using ozone cleaning, or plasma cleaning) to remove most hydrocarbon material from the surface, before loading into the SEM.
- › The wafer will be loaded on a dedicated wafer sample mount on the SEM stage.
 - › If there is no standard sample mount for 2" wafers, a 3" or 4" wafer may also be used instead.
- › The system is pumped down to ultra high vacuum.
- › Set the working distance to the eucentric working height of the system.
- › The electron beam is focused on the edge of the wafer, set to the following beam settings:
 - › 5 kV accelerator voltage
 - › 1 nA beam current (can be tuned in following steps)
- › Then the stage is moved to the approximate centre of the wafer



› SAMPLES TO BE LOADED

- › Switch to EDX data acquisition.
 - › Perform analysis on a square area of 100 μm x 100 μm .
 - › Tune beam current to obtain acceptable amount of counts per second and dead time.
 - › Target total counts of the Si K α peak: ~5000 counts after 5 minutes of acquisition time.
 - › Prevent larger beam currents to reduce possible thermal effects (surface heating).
 - › The above can first be tested on one position of the wafer to obtain proper beam settings. Then when these settings are determined, go to another location to perform the actual test on.
 - › Acquire for 5 minutes to obtain an EDX spectrum.
 - › Save the spectrum data.
 - › Acquire data on the exact same area again for 5 minutes, and save the spectrum data.
 - › Repeat this to obtain 6 EDX spectra of each 5 minutes acquisition time.
 - › Quantify each spectrum using Si, O and C elements, express each element abundance in at%.
 - › Report this in a table with the element abundances of all the spectra.
 - › If an increasing trend of C is visible, calculate the C at%/min increase by calculating the at% C increase from the 3rd spectrum to the 6th spectrum and dividing it by 15 minutes.
- › Test result pass requirement:
 - › The carbon abundance shall be less than 5 at% at the 6th EDX spectrum. ← requirement R-4000-005
 - › The linear carbon trend (if observed) should be less than 0.1 at%/min. ← requirement R-4000-010



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