Introducing the ALTO Series (Cryo System)

The ALTO series from Gatan UK is a cryo transfer system for SEM and combined ion beam systems. The series has two models, ALT 2500 (Figure 1) for field emission SEM and ALTO 1000 (Figure 2) for conventional SEM.

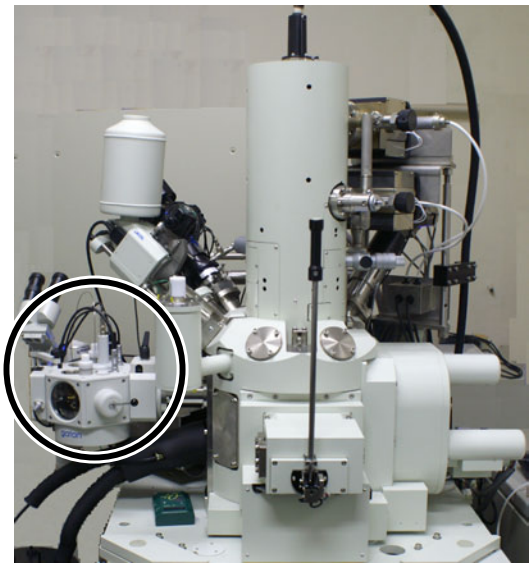

Figure 1. External view of ALTO 2500

ALTO 2500 installed in JIB-4600F

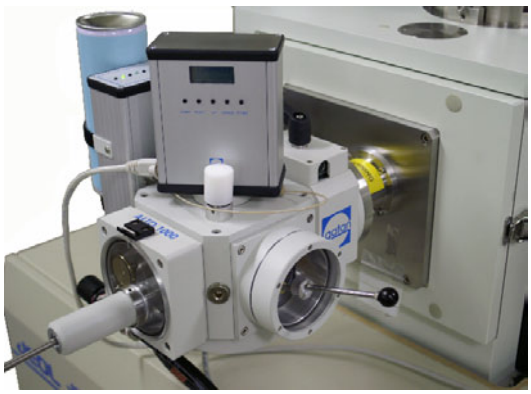

Figure 2. External view of ALTO 1000

ALTO 1000 installed in JIB-4600F

Each system comprises a cryo (preparation) chamber and a cold stage. Figure 3 is a schematic diagram of an ALTO 2500 system.

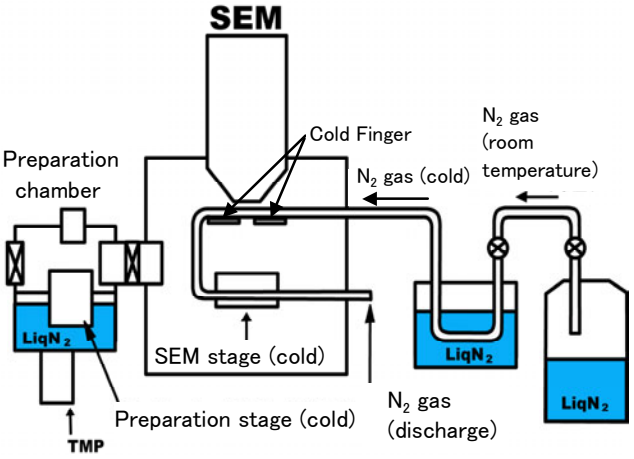

Figure 3. ALTO 2500 System

The figure illustrates an ALTO 2500. The system uses nitrogen gas chilled with liquid nitrogen to keep the SEM stage and cold fin cold. The cryo chamber is evacuated by a single turbo molecular pump.

As a coolant, nitrogen gas cooled down to liquid nitrogen temperature is circulated through a tube inside the SEM specimen chamber, cooling the cold trap fin and the stage. Figure 4 shows an optional nitrogen gas tank on the left and a nitrogen gas cooling bath on the right.

Figure 4. Nitrogen gas tank (left) and nitrogen gas cooling bath (right)

The nitrogen gas from the nitrogen gas tank shown on the left is cooled down to liquid nitrogen temperature in the nitrogen gas cooling tank shown on the right. It is then circulated in the SEM specimen chamber through the tube, cooling the fin, the stage, and the specimen.

The ultimate temperature, -190°C (Figure 5), is achieved quickly in about 15 minutes.

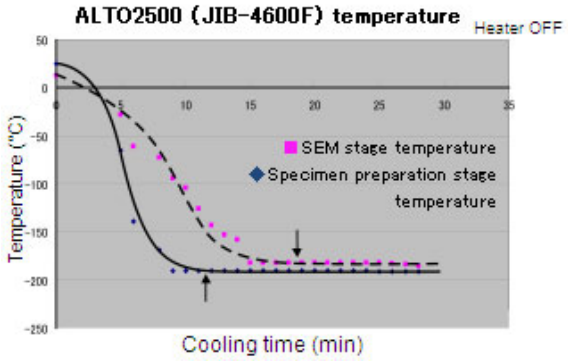

Figure 5. Cooling characteristics of ALTO 2500 - 1
The solid line represents the cryo chamber, while the dashed line the cold stage. The cold stage reaches -190°C in about 15 minutes.

The stage temperature can be controlled by a heater with an accuracy of ±1°C (Figure 6).

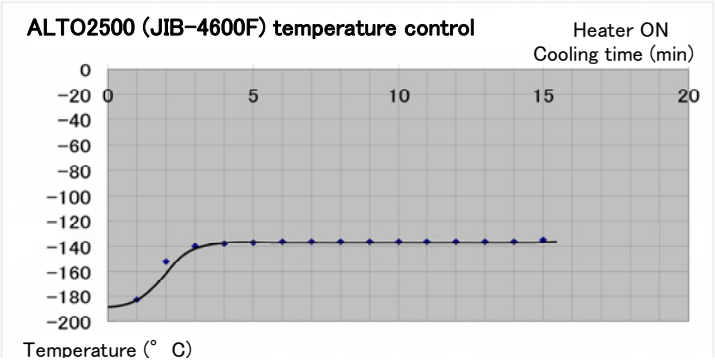

Figure 6. Cooling characteristics of ALTO 2500 - 2
The stage temperature can be controlled by a heater with an accuracy of ±1°C.

This enables accurate sublimation (etching) of ice according to the vacuum level in the SEM specimen chamber. It also minimizes the stage drift due to temperature fluctuation. It also allows the user to control or stop etching rates. The cryo chamber (Figure 7) is constantly evacuated by a separate turbo molecular pump to keep the specimen chamber in high vacuum. The specimen stub temperature can be controlled by the heater. The chamber integrates a cold knife (Figure 8) and a cold sputterer head for sample coating with metals such as Pt and Au-Pd.

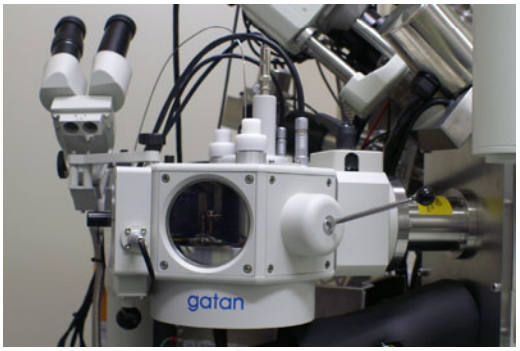

Figure 7. ALTO 2500 cryo chamber
A large viewing window facilitates sample processing.

Figure 8. Cutting a sample with the cold knife
A sample is cut with the cold knife integrated in the chamber. The sample is positioned using the binocular microscope attached.

The system also comes with a standard slush chamber (Figure 9) to create slush nitrogen (semi solid nitrogen) for rapid freezing, enabling sample freezing without coolant boiling. The specimen exchange rod incorporates a transfer tube to transfer the frozen sample from the slush chamber to the cryo chamber in vacuum (Figure 10).

Figure 9. Slush chamber

The slush chamber, a standard accessory, is designed to evacuate liquid nitrogen to create slush (semi solid) nitrogen. This semi solid nitrogen is used for rapid freezing without coolant boiling.

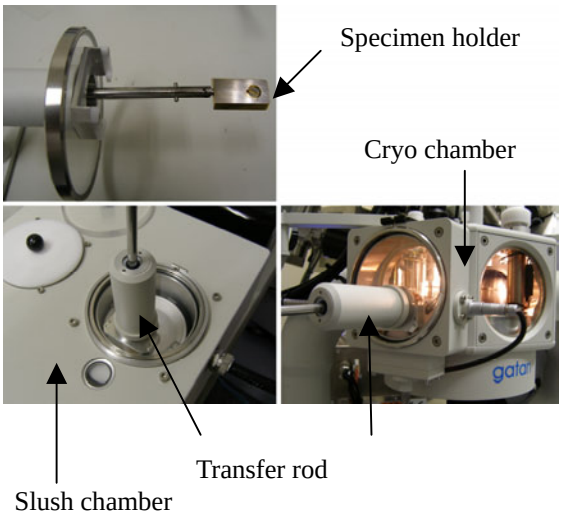

Figure 10. Transfer rod

The sample, after rapidly frozen with slush nitrogen, can be transferred in vacuum to the cryo chamber by loading the specimen holder onto the transfer rod.

ALTO 1000 has the same cold stage as ALTO 2500. Differences are that the cryo chamber is not evacuated by a turbo molecular pump, and that the cold knife and sputter coater are optional. ALTO 1000 supports nitrogen gas leak during low vacuum SEM imaging, preventing frost formation. This feature enables backscattered electron imaging of uncoated samples at high accelerating voltage, allowing for imaging of the etching process (Figures 11-1 and 11-2).

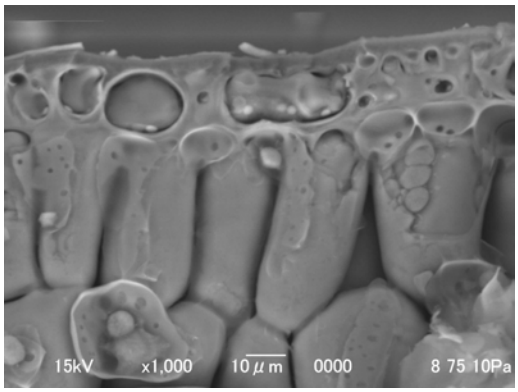

Figure 11-1. Cross section of plant leaf (unetched)

Vacuum: 20 Pa (BEI); sample temperature: -110°C

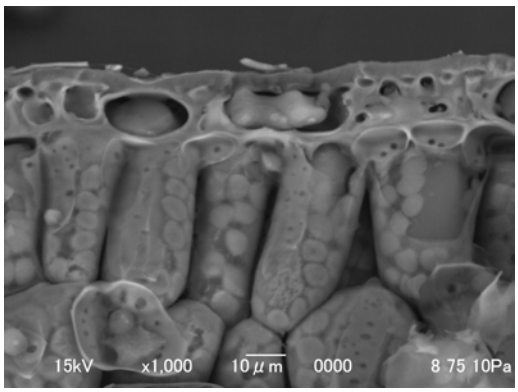

Figure 11-2. Cross section of plant leaf (etched)

Vacuum: 20 Pa (BEI); sample temperature: -70°C

Figures 11-1 and 11-2 are low vacuum backscattered electron images. The etched sample in Figure 11-2 shows the cell structure that is not visible in Figure 11-1.