

## Long-term measurement using variable temperature controller (ES-13060DVT5)

Product used : Electron Spin Resonance (ESR)

### ■ Variable temperature controller (ES-13060DVT5)

The variable temperature controller can be combined with the cavity to enable ESR measurements in the temperature range of  $-170\text{ }^{\circ}\text{C}$  to  $+200\text{ }^{\circ}\text{C}$ . The temperature is controlled by heating liquid nitrogen (low temperature range) or air (high temperature range). The 10 L dewar is the standard, the 30 L dewar is available as an option, which can be used for long-term temperature control. The continuous operation time at low temperature is approximately 70 minutes at  $-160\text{ }^{\circ}\text{C}$  and approximately 90 minutes at  $-150\text{ }^{\circ}\text{C}$  with a 10 L dewar, but with a 30 L dewar, it can be operated for approximately 3 times longer at any temperature. With this controller, the ESR measurement can be performed while changing the temperature as well as the fixed temperature. If the measurement temperature is to be changed automatically and continuously, it is necessary to readjust the microwave conditions (frequency, coupling, etc.) for each temperature, but it is possible to have the ESR spectrometer do it automatically.

### ■ Application

Using the quartz sample extracted from the sediment irradiated with gamma rays, automatic continuous ESR measurement was performed while raising the temperature by  $2\text{ }^{\circ}\text{C}$  in the range of  $-150$  to  $50\text{ }^{\circ}\text{C}$ . The measurement time, including readjustment of the microwave conditions at each temperature, was approximately 7 hours. With a 10 L dewar, liquid nitrogen was depleted in about 5 hours, so the measurement could not be continued.

At  $-150\text{ }^{\circ}\text{C}$ , the Al center and the Ti-Li center were clearly observed. As the temperature increased, the relaxation time ( $T_2$ ) of these paramagnetic centers rapidly shortened, and the signal intensity decreased with the disappearance of fine spectral structure due to broadening the line width (Figure 1). It is almost no longer observable at  $24\text{ }^{\circ}\text{C}$ . Figure 2 shows contour plots of all ESR spectra (101 spectra) from  $-150$  to  $50\text{ }^{\circ}\text{C}$ . This figure shows the temperature dependence of the line width and the intensity for each component. Using the variable temperature controller with a 30 L dewar, it is possible to measure ESR signals at low temperature for long-term.

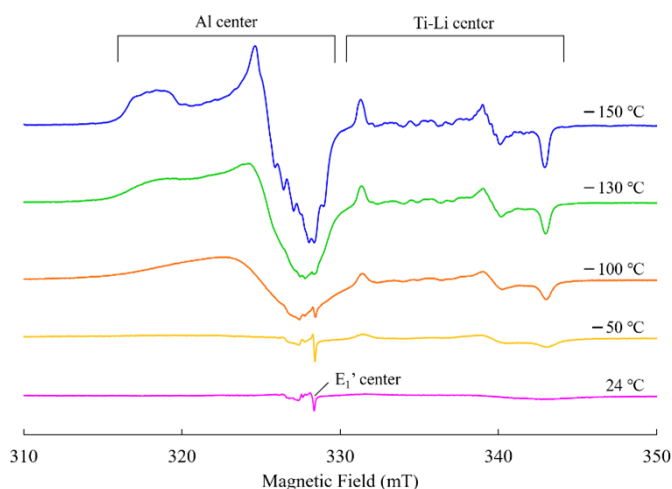


Figure 1. Temperature dependence of quartz ESR signal.

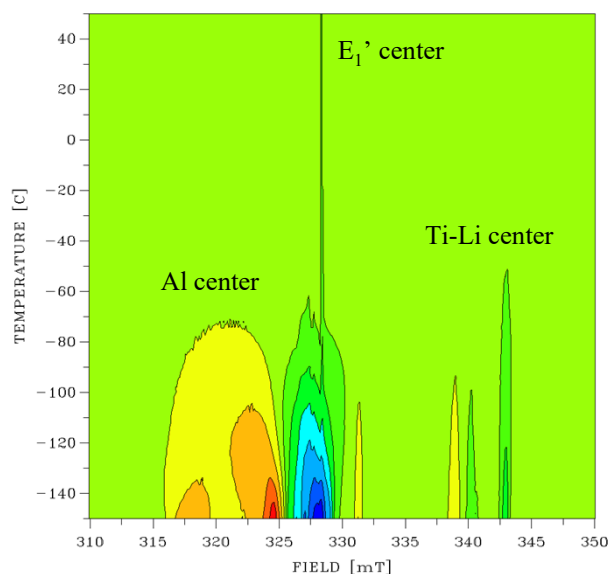


Figure 2. Temperature dependence of quartz ESR signal.

Copyright © 2022 JEOL Ltd.

Certain products in this brochure are controlled under the "Foreign Exchange and Foreign Trade Law" of Japan in compliance with international security export control. JEOL Ltd. must provide the Japanese Government with "End-user's Statement of Assurance" and "End-use Certificate" in order to obtain the export license needed for export from Japan. If the product to be exported is in this category, the end user will be asked to fill in these certificate forms.

