Frequency Sweep ESR Spectrometer for Dosimetry and Dating

Hidemoto Hara*, H. Morishima**, H. Kawai**and Y. Nishiwaki**.

* Micro Divice Co.,Ltd.
1-2-6 Komagome Toshima-ku, Tokyo 170, Japan

** Atomic Energy Research Institute of Kinki University
3-4-1 Kowakae, Higashi-Osaka City, Osaka 577, Japan

For the study of radiation damage in matter, ESR (Electron Spin Resonance) is widely used these days and much progress has been achieved in the method of measuring ESR signals. However, with the standard type ESR equipment, a large electromagnet and regulated power supply are set up and quite a large area is required in the laboratory. Therefore, it is impossible to conduct an experiment on site outside the laboratory with such a large equipment. For dosimetry with such a large ESR equipment it is required that the samples to be used for ESR-dosimetry have to be brought back to the laboratory for measurement. In order to facilitate the ESR measurement on site outside the laboratory in nuclear accident or emergency or for the purpose of dating of ancient natural samples at remote places, we are trying to build an experimental, small-sized ESR equipment, which is capable of transforming into a battery powered portable version.

With the first type of portable ESR spectrometer which was developed, the feasibility as a reader of alanine dosimeter was studied.The developed ESR spectrometer was designed to be small enough that it can be placed on a two-feet-square desk, however it has the functions of high magnetic field modulation, high frequency modulation, variable amplitude and AFC(Automatic Frequency Control)function in order not to sacrifice sensitivity, stability and reproducibility. The spectrometer has

two main components of a permanent rare-earth metal magnet and resonator part, and a unit box with a microwave circuit, an AFC circuit,a sweep controller of magnetic field, an oscilloscope, etc. Sensitivity was improved by using FET (Field Effect Transistor) amplifier in a resonance detector circuit.

With the second type of portable ESR spectrometer, it is intended to measure ESR signals of shell goods such as button and human teeth which were irradiated by nuclear radiation accidentally. For this purpose we are trying to develop ESR equipment using a strong permanent magnet and microwave modulation. Conventional ESR equipment consists of a system whereby resonance is detected by fixing the microwave frequency and sweeping the magnetic field, while the equipment we are trying to develop uses the method whereby ESR signal is detected by fixing the magnetic field and sweeping the microwave frequency. The high Q-value sample cavity has been coupled with the low Q-value oscillation cavity through the iris hole. Voltage impressed to the tuning diode inside the sample cavity gives shift to the resonance frequency, simultaneously controlling the oscillation frequency. About 100 megaherz frequency sweepings have been used by giving thaw toothed modulation. Magnetic field has been fixed to an adequate value by controlling the gap of the permanent magnet.

At present, the sensitivity of this equipment is too low to be used for the measurement of low radiation dose range for routine radiation protection purposes. Therefore, it is now intended to develop an equipment to be used to screen the persons who would have received unusually high dose of radiation accidentally in case of nuclear accident or emergency. In such cases, ordinary dosimeter designed for measurement of low dose of radiation for routine radiation protection purposes may not be usable. Under such emergency cases, ESR equipment must be brought as close to the site of accident as possible, in order to facilitate the

prompt screening of the persons who are exposed to unusually high dose of radiation, using ESR signals of shell button, sugar coating of the medicine carried by the person or human teeth if available. We are now trying to improve the sensitivity and reproducibility of this type of portable equipment.

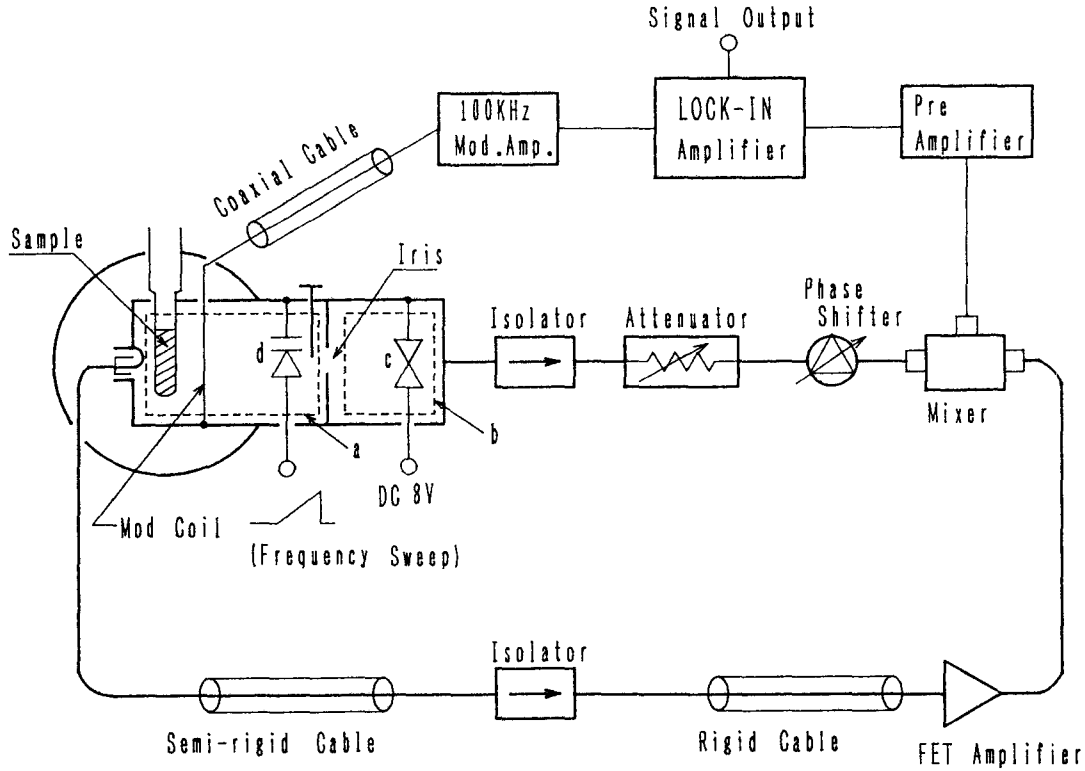
References

1) Y. Nishiwaki, H. Hara, T. Shimano, T. Nakajima: ESR Dosimeter for the Public in Nuclear Emergency. Proceedings of the International Conference "Emergency '88" London, 1988.

2) Y. Nishiwaki and T. Shimono: Uncertainties in Dose Estimation under Emergency Conditions and ESR Dosimetry with Human Teeth, Proceedings of the Ninth International Conference on Solid State Dosimetry, 295-297, Seibersdorf, Austria (1990) .

3) T. Nakajima, Y. Nishiwaki et al.: ESR Sensitivity Comparison of Sugar from Various Sources and Cavity Mode Effect, Proceedings of the Ninth International Conference on Solid State Dosimetry, 303-306, Seibersdorf, Austria (1990) .

4) H. Hara, Y. Nishiwaki et al.: Frequency Sweep ESR Spectrometer for Dosimetry and Dating, Proceedings of the Ninth International Conference on Solid State Dosimetry, 335-337, Seibersdorf, Austria (1990) .



a:Sample Cavity c:Gunn Diode
b:Oscillation Cavity d:Tuning Diode

<Frequency Sweep ESR Block diagram>