# Radio frequency detection system designed for scanning probe microscopy

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Interaction between electromagnetic field at a radio frequency (RF) and materials is one of the most important probes to investigate characteristic properties of materials. Expansion of the measurable frequency to the wider bandwidth of 10 Hz to 200 GHz has been investigated, for example, to develop the electron spin resonance STM (ESR-STM) which detects a single spin precession under a week magnetic field, enabling single spin detection, for example, in a molecule or in nanoscale electric/optoelectric devices that work in microwave frequency ranges. For such applications, the system should have an ultrahigh sensitivity to detect a very low energy signal from a lone pair electron or microscale/nanoscale electric devises. In general, however, ultalow noise and ultrawide bandwidth are conflicting requirements and it is difficult to realize them together.

We have designed a system for this purpose (Fig. 1), which is composed of a vector network analyzer, a spectrum analyzer with fast Fourier transformation and a vector servo-analyzer as a signal analyzer, and a pulse generator, a signal sweeper and a function generator as a signal injection source capable of the heterodyne detection. The performance of the designed system was examined by a model experiment. A very weak (-130 dBm) RF signal at 2 GHz was fed into the HOPG specimen and the signal to noise ratio was measured by the spectrum analyzer. The effective amplification of the RF preamplifier was about 15 dB and the final signal to noise ration of 22 dBm was achieved.

Details will be discussed at the colloquium.

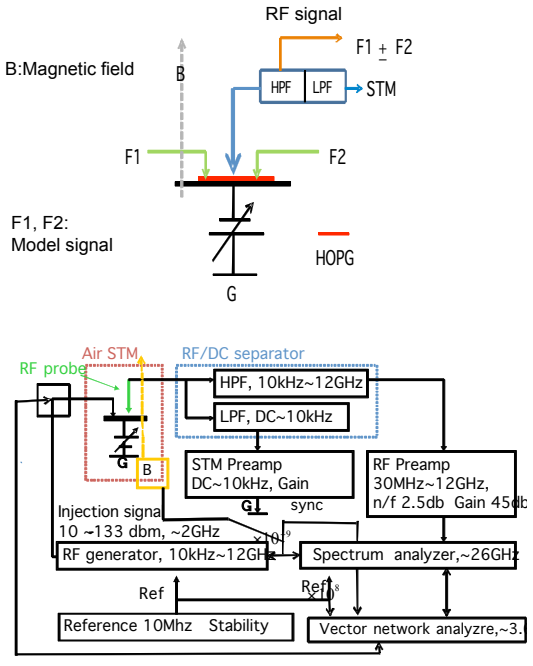


Fig. 1 Schematic diagram of the system we developed. A magnification of the probe setup is shown in the upper part.