Development of scanning microwave impedance microscopy using heterodyne technique

Ryo Izumi[1], Yoshitaka Naitoh[1], Yan Jun Li[1] and Yasuhiro Sugawara[1]

[1] *Department of Applied Physics, Graduate School of Engineering, Osaka University, 2-1 Yamadaoka, Suita, Osaka 565-0871, Japan*
izumi@ap.eng.osaka-u.ac.jp

The size of a transistor in large scale integrated circuits is getting smaller and smaller. In addition, as the communication technology advances, telecommunications equipments have required semiconductor devices which work precisely at microwave frequency. Because of these reasons, measurement techniques which can map electrical properties at microwave frequency with high spatial resolution are required. Scanning microwave impedance microscopy (sMIM) is one of the most powerful tool that can observe electrical properties (e.g. dielectric constant and conductivity) of samples with high spatial resolution[1]. In contrast to other microscope technique, such as KPFM[2], sMIM has an advantage of high frequency (microwave frequency) operation. In this study, we have developed sMIM with heterodyne technique which detects the differential component with respect to the tip-sample distance.

Figure 1 shows the block diagram of the heterodyne sMIM. In the system, microwave signal is transmitted to a cantilever tip and then reflected. When the cantilever is vibrated at a frequency f_0, the reflected signal from the tip contains frequencies of not only f component but also $f \pm f_0$ components. These components have information of the derivative of tip-sample capacitance with respect to the tip-sample distance. In the heterodyne sMIM, these $f \pm f_0$ components are detected to map electrical properties of a sample.

In the presentation, we are going to talk about the mechanism of sMIM with heterodyne technique and the images obtained with this technique.

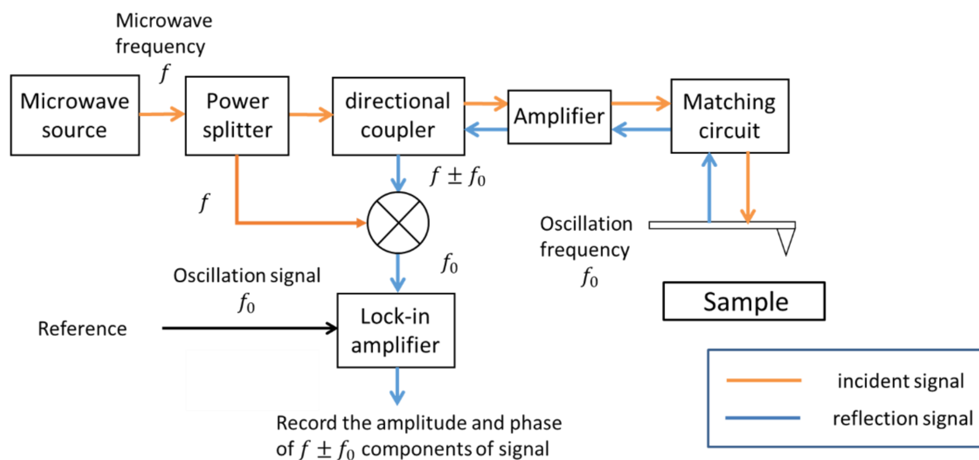

Figure 1. Block diagram of sMIM using heterodyne technique.

[1] K.Lai et al, *Rev. Sci. Instrum.* 79, 063703 (2008).
[2] M. Nonnenmacher et al, *Appl. Phys. Lett.* 58, 2921 (1991).