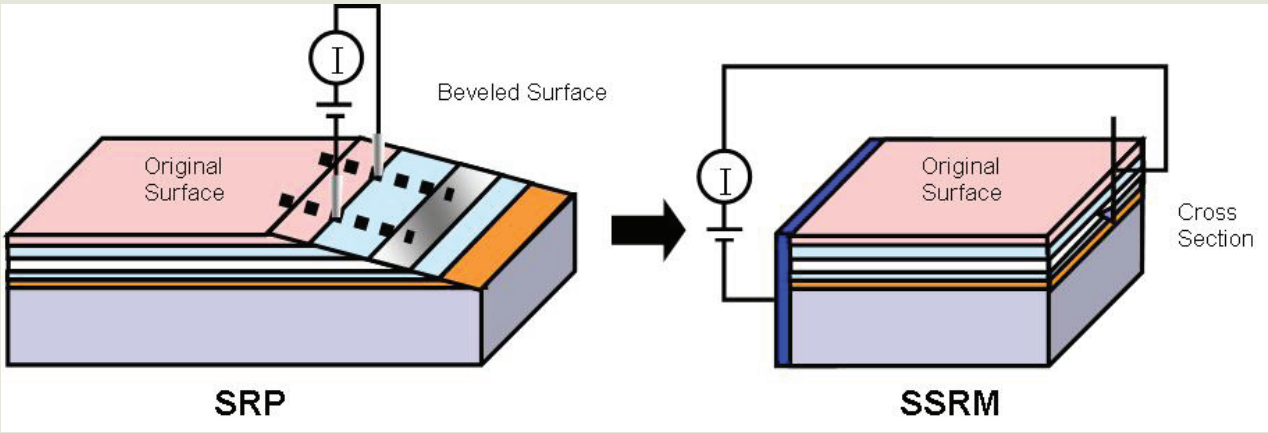
Scanning Spreading Resistance Microscopy (SSRM)

Probing the Local Electronic Structure of a Sample's Surface



SSRM is an implementation of a well-established Spreading Resistance Profiling (SRP) method used for micro and nano-scale. A generic SRP, however, is a dual probe technique, while in SSRM a conductive AFM tip scans a small device region with a common electrode, as shown in Figure 1. The operation of Conductive-AFM and SSRM is identical except that SSRM scans the cross-sectioned surface of a device, while in Conductive-AFM a generalized surface is scanned. The applications of SSRM include determination of dopant distribution in semiconductor materials as well as exact pn-junction delineation.

To improve the depth resolution, the samples for the conventional dual probe SRP require preparation of beveled surfaces, whose quality has been found to significantly affect the measured contact resistance.

Moreover, certain corrections are needed to account for junction shifts from carrier diffusion due to the beveled surfaces. In contrast, SSRM offers a much higher spatial resolution (several times less than a tip radius) and eliminates the need for surface beveling. SRP tip curvature radius is usually 10 µm tungsten alloy stylus as opposed to 50-100 nm (or even smaller) for diamond like carbon coated (DLC) SSRM tip. A voltage bias used for SRP are in order of magnitude higher than those for SSRM. Dynamic range for carrier concentrations in both n- and p-type Si covers five orders of magnitude 10^{15} -10^{20} cm^{-3}.

There are two SSRM modes according to the current amplifier being used. They are 'Internal SSRM' and 'External SSRM'. The 'Internal SSRM' mode refers to the SSRM mode that uses the current amplifier with fixed gain in the head extension module. The 'External SSRM' mode refers to the SSRM mode that uses the external low noise current amplifier with variable gain. In the external SSRM mode, measurable current range can be changed by varying the gain of the amplifier. (See "External Low Current Amplifier")

Specifications

Common

Carrier concentration: 10^{15} ~ 10^{20} carriers/cm^3
Lateral Resolution: 10 nm

External

Transimpedance: 10^3 ~ 10^{11} V/A
4.3 fA / √Hz Input Noise
Bandwidth: up to 500 KHz
Bias voltage range: -10 ~ +10 V
Current range: 1 pA ~ 10 mA

Internal

Current range: 10 pA ~ 100 mA
DC bias range: -10 V ~ +10 V
(in 0.001 V increments)
Noise level: 10 pA