	Experiment title: In-situ measurements of electromigration in Cu lines using white beam microdiffraction	**Experiment number**: MA-936
Beamline: BM32	**Date of experiment**: from: 17th February 2010 to: 23rd February 2010	**Date of report**: 09/03/2010
Shifts: 18	**Local contact(s)**: Xavier Biquard	*Received at ESRF:*

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Report:

The experiment aimed at tracking grains behavior in copper lines during electromigration using Laue microdiffraction (see proposal MA936). Samples were all prepared at St Microelectronics and consisted of copper lines of 50 micrometers long, 200nm thick and 200nm wide. Other lines were as large as 1 micrometer. With respect to previous experiments, lines were chosen slightly bigger to get more signal out of them.

To make electromigration compatible with scanning times, it is necessary to heat samples up while stressing them with a rather high current density, that can reach several mA per square micrometer. An Anton-Paar furnace, provided by the beamline staff, was used and the temperature was maintained to 350°C according to our previous experiences. The polychromatic beam size was about a micrometer in both direction and images recorded thanks to a MAR 165 CCD camera.

Basically, the experiment consisted in aligning the copper line with respect to the beam, thanks to a visible microscope, finding both extrimities of the line and iteratively scanning the line while collecting x-ray Laue diffraction images. The process has been repeated several times on several lines. A little less than 3 shifts per samples were necessary to observe a clear electromigration effect thanks to the resistance that is monitored in-line using our own current source..

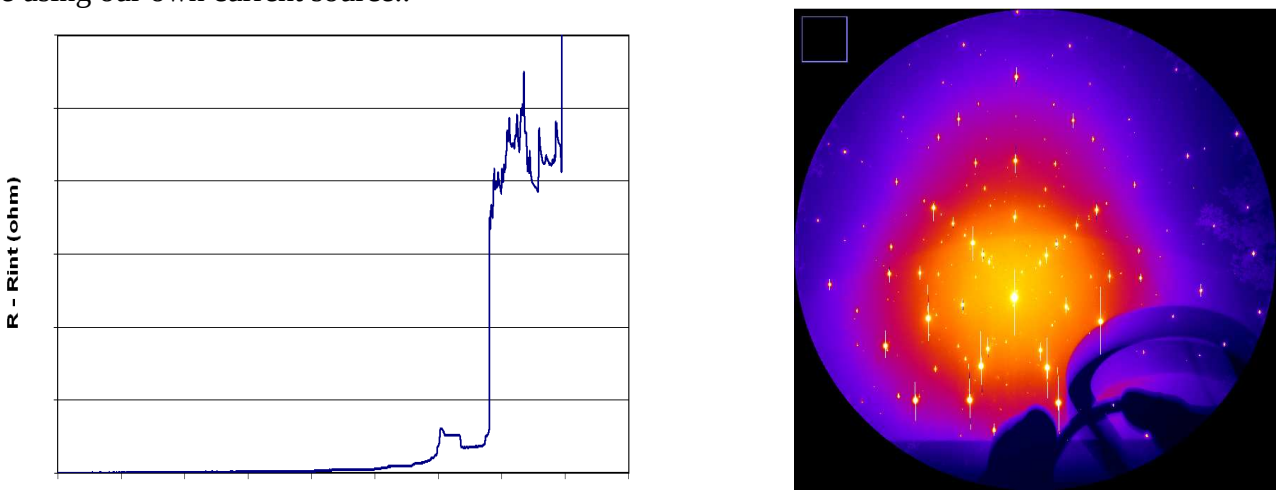

Fig1: Resistance variation as a function of time (left). Typical non-background corrected Laue diffraction image (right)

As can be seen on Figure 1, on diffraction images are superimposed signals coming from (i) the silicon, (ii) the germanium, that is inserted between the chip and the ceramic to prevent from unindexable peaks and(iii) some more diffuse spots coming from the copper line itself. The exposition was set to 60s per point: in that as, Si peaks saturate the detector but Cu peaks become seeable.
Figure 2 shows an in-situ tracking of a particular Cu spot during time. Clearly, the spot is moving (by about 3mm on the camera), that may indicate a grain rotation by more than 2 degrees during electromigration. Of course, this spot motion is measured with respect to non-moving spots like Ge or Si ones to get rid of potential samples drifts during the measurements.

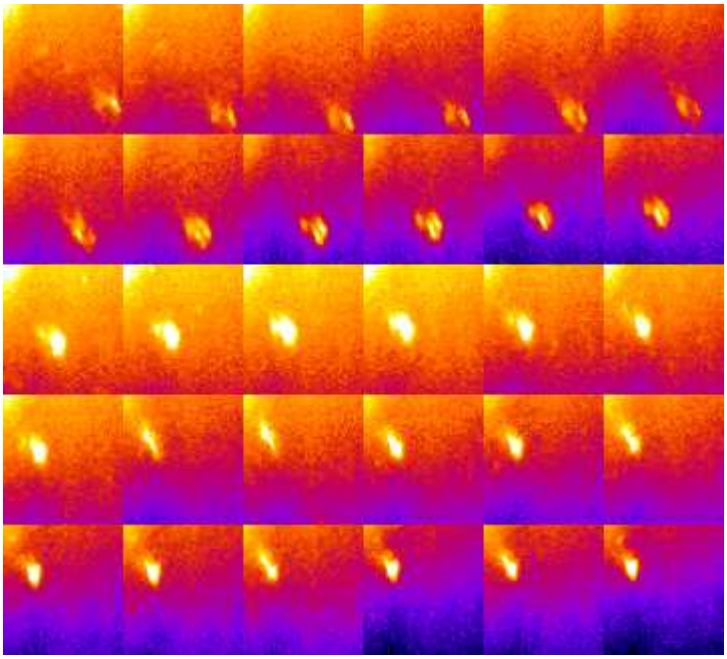

Fig2: ROI on the CCD showing the spatial evolution of a Cu diffracted spot during electromigration. A sub-image is 60 pixels wide; a pixel is about 80micrometers.

These observations are really preliminary but confirm our past observations and are compatible with other experiments performed by other teams at ALS (Tamura et al.)
With experiment MA936, a large amount of data have been acquired. The analysis is ongoing: it consists in (i) making sure that all spots come from Cu, (ii) validate this grain rotation on several reflections and several samples, (iii) try to extract a rotation profile along the line and, overall, understand the mechanics of grain rotation. For that purpose, ongoing EBSD measurements are being made.