D6.5 AT LEAST TWO EXAMPLE DATASETS OF REPRESENTATIVE MEASUREMENTS OF CHARACTERISTIC SAMPLES TO DEMONSTRATE SMM CAPABILITIES AND CHALLENGES

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1 EXECUTIVE SUMMARY

1.1 Description of the deliverable content and purpose

Deliverable D6.5: At least two example datasets of representative measurements of characteristic samples to demonstrate SMM capabilities and challenges.

The deliverable contains two datasets taken with SMM, the datasets have full metadata and a short description of them is given here. The purpose of this datasets is to show to interested parties what can be results and possible challenges of SMM measurements.
The complete datasets will be uploaded to MMAMA's open Innovation Platform (https://www.mmama.eu/oip/) and Zenodo.

1.2 Brief description of the state of the art and the innovation breakthroughs

N.A.

1.3 Corrective action (if relevant)

N.A.

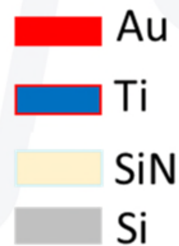
1.4 IPR issues (if relevant)

N.A.

2 Dataset 1

2.1 Sample description

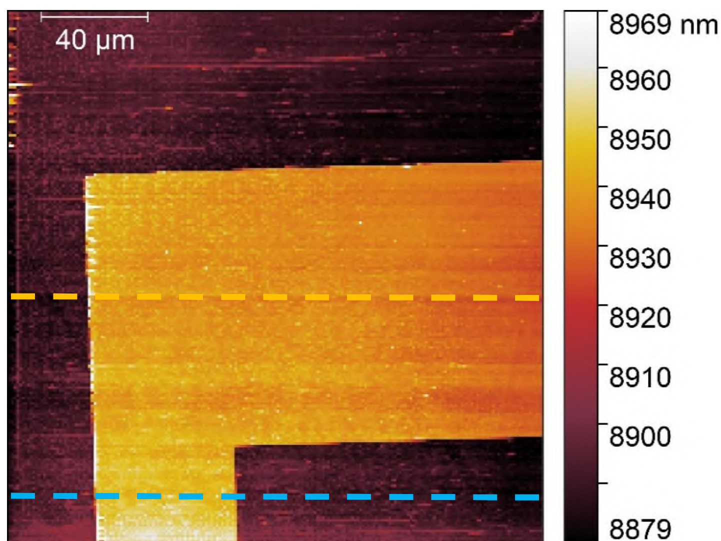
- Si wafer: resistivity range: 0.1-0.5 Ohm.cm (boron-doped)
- 45 nm thick Au, 5 nm thick Ti, 500 nm thickn SiN, 380 micron thick Si



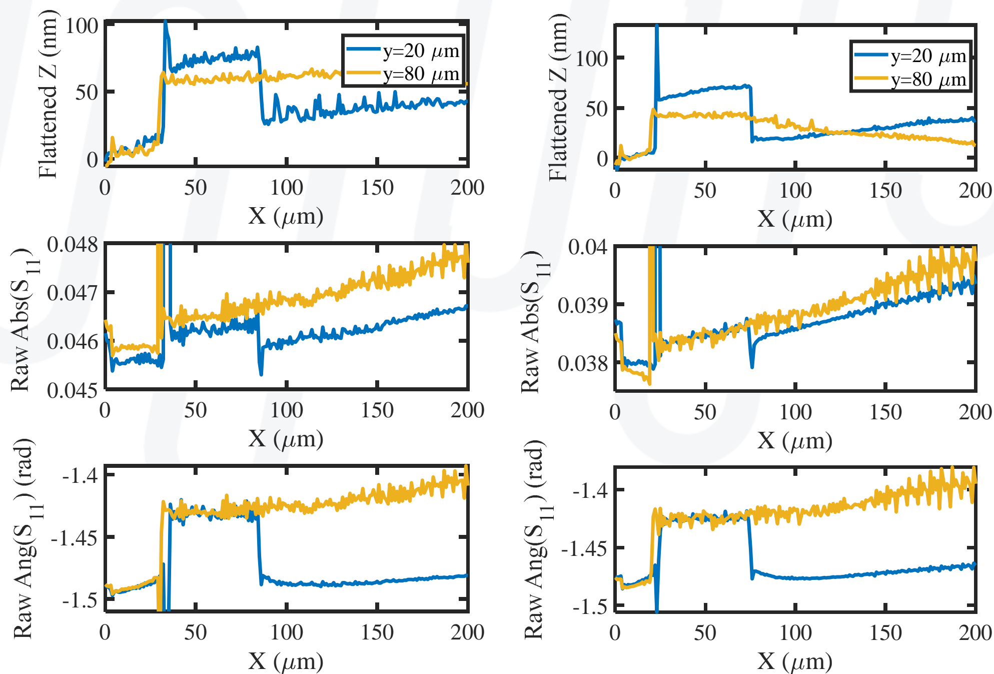
2.2 Results

File1=XYScanNano_200x200um_201x201px_MMAMAtestsample_QUTO_190606_210107

File2=XYScanNano_200x200um_201x201px_MMAMAtestsample_QUTO_190606_224642



1 Figure Topography. Dashed lines indicate location of profiles



2 Profiles of topology (top panels), magnitude (middel panels) and phase (bottom panels) of S11 extracted from file 1 (left column) and file 2 (right column). Regions where gold films stay (higher Z value) provide stronger signals in both phase and magnitude of S11

2.3 Challenges

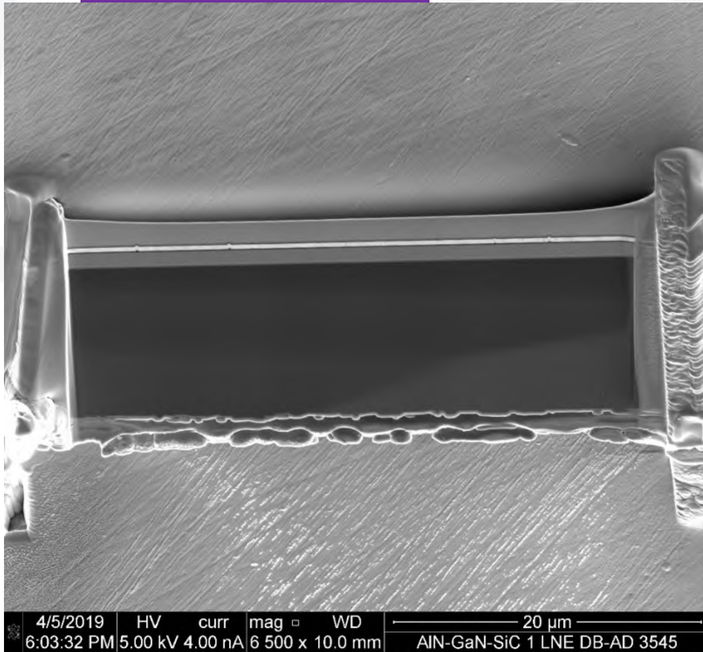
AFM artefacts: noise, unoptimized feedback loop

Technical challenges in term of RF physics: contribution coming from external environment. Here, the two measurements (file1 and file2) were done at similar structures, which stay more than 4 mm away from each other

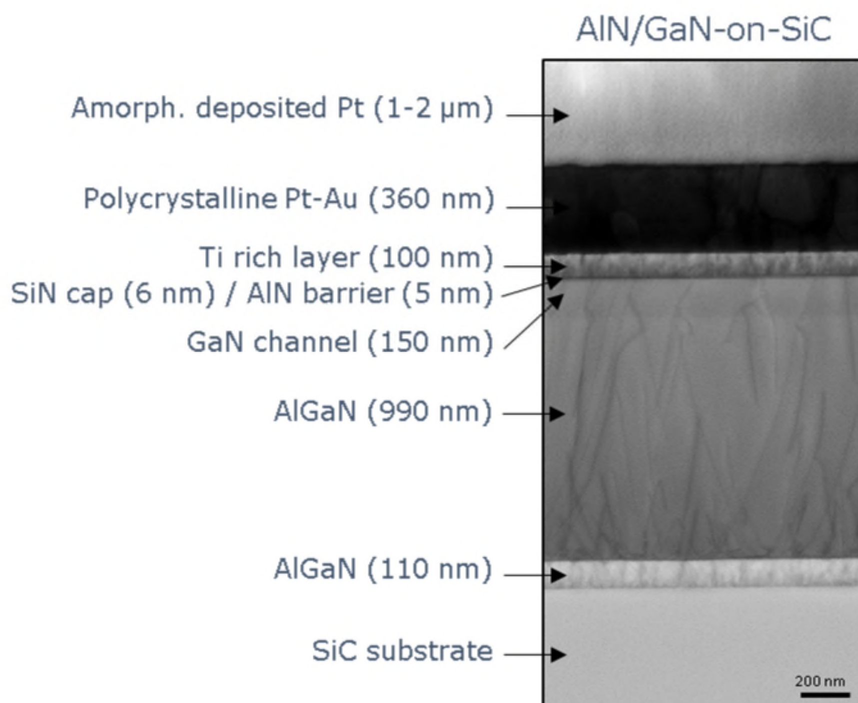
Metadata of file1 and file2 can be read using Gwyddion.

3 DATASET 2

3.1 Sample Description



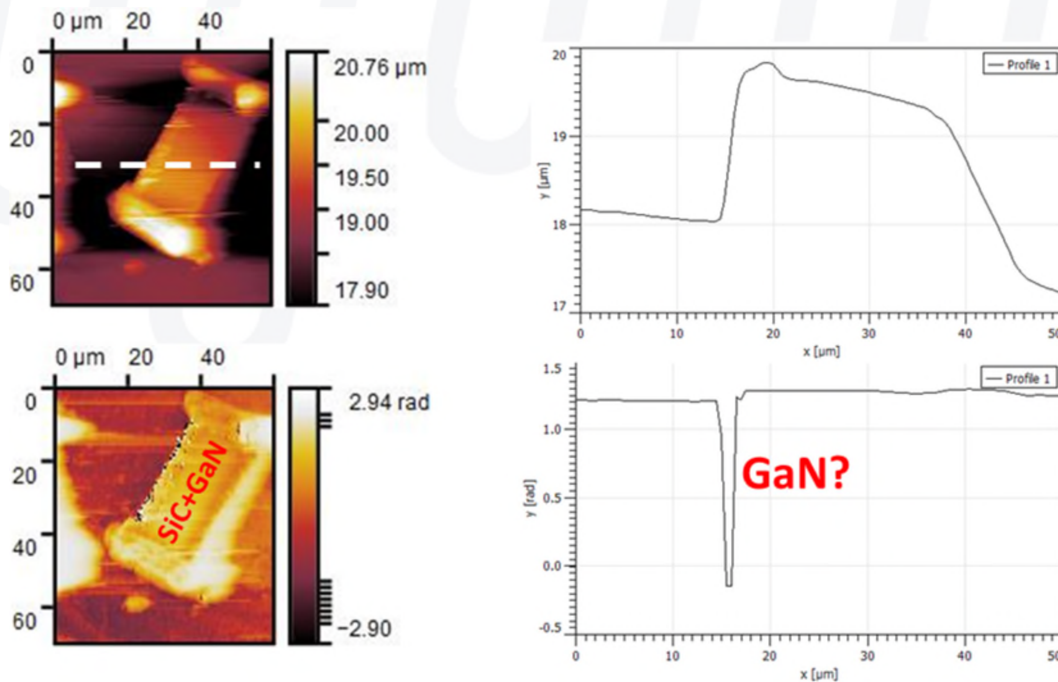
3 SEM image of lamella of GaN chip. A top-view image of a lamellae produced using focus ion beam technique. The sample was glued to a gold coated sample holder.



4 A zoomed image of the region of interest, where layers of different materials locate (framed region in left panel). As shown, the region consists of layers with different electrical properties: metallic (Pt, Au, Ti, with total thickness of about 2 micron), semiconducting AlGaN+GaN (total thickness of about 1.3 micron) and dielectric SiC substrate.

3.2 Results

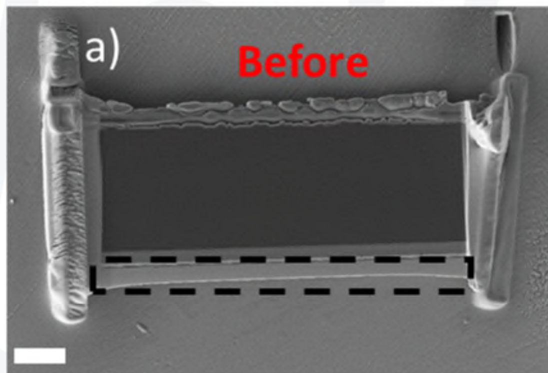
File3=XYScanNano_60.0x70.0um_120x140px_Al_GaNonSiC1_217.41_200409_010259.gwy

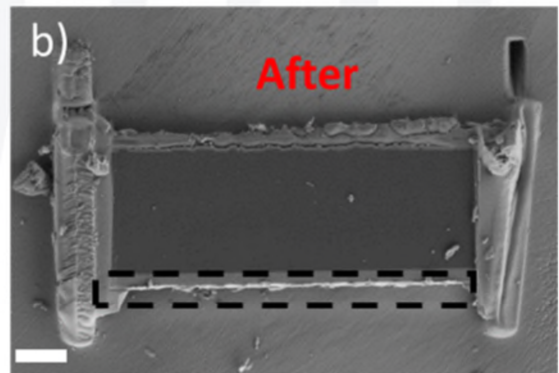


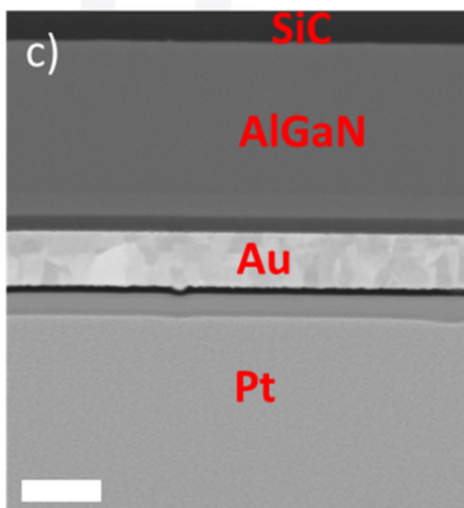
5 Top panels: A 2D topography map and a profile extracted from this map along the dashed white line. Bottom panels: A 2D map of the magnitude of S11 and a similarly extracted profile. The thin lamella is visible in both topography and electrical maps. However, it is difficult to determine the position of GaN/AlGaN multilayers from SiC from profies extracted from these maps (right panels). The position of the film edges cannot be determined precisely because of the tip convolution. In turn, it is possible to guess the position of the GaN/AlGaN layers. Moreover, the lack of contrast in the electrical measurement between GaN/AlGaN and SiC is attributed to the small difference in electrical properties of these materials (both is non-conducting and have similar dielectric constants: ε_{GaN}=5.3 ε_{SiC}=6.52 at high frequency [1]).

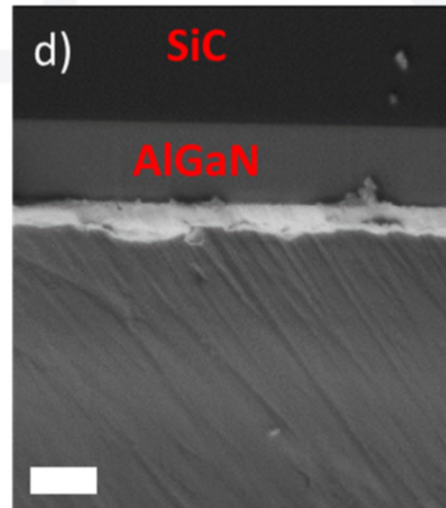
[1]: Bougrov V, et al., Properties of Advanced semiconductor materials GaN, John Wilye & Sons, Inc. New York, 2001

3.3 Challenges









6a) and b) Scanning electron microscopic (SEM) image taken before and after SMM measurements. Black dashed frames in a) and b) points at the zone of interest, where multilayers stay. However, as shown in b), this region was damaged during the SMM measurements. We expect that the tip, which is in contact with the sample, removed part of the metallic layers deposited during the production of this lamella. c) and d) are SEM images zoomed in the region of interest. The scale bars in a), b), c) and d) are 5 µm, 5 µm, 500 nm and 1 µm respectively.

Metadata can be read from file3 with Gwyddion.