Nanoscale electrical properties of ZnO/NiO co-deposited thin film investigated by Scanning Probe Microscopy techniques
A. S. Borowiak¹, O. Nakagawara², L. Mingyù¹, G. Tan¹, H. Tanaka¹
E-mail: alexis.borowiak@live.fr, alexis.borowiak@sanken.osaka-u.ac.jp

¹ Institute of Scientific and Industrial Research, Osaka University, 8-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan
² Murata Manufacturing Co., Ltd., 1-10-1 Higashikoutari, Nagaokakyōshi, Kyoto 617-8555, Japan

In our previous work, we have already reported that a self-assembled ZnO/NiO heterostructure composed of a three-dimensional nanopillar (NiO)/matrix (ZnO) structure was successfully created on Nb: SrTiO₃(111) substrate by pulsed laser deposition¹. At that time, it was difficult to discriminate nanoscale component via Scanning Probe Microscopy (SPM) techniques and Scanning Electron Microscopy (SEM) images especially when NiO pillars have a size and the distance between pillars are below the Atomic Force Microscopy (AFM) tip apex (30-50 nm). In this work we report the nanoscale study of Zn, Ni (8:2)O thin film grown on Nb: SrTiO₃ substrate via Scanning Probe Microscopy techniques with sharper AFM tips. SPM and SEM images well agree and reveal that the surface is composed of various topographical pillars with various size embed in a flat matrix. Piezoresponse Force Microscopy (PFM) and C-AFM techniques have been used and are really useful for this study because ZnO has piezoelectric and semi-conducting properties while NiO has non-piezoelectric and non-conductive properties. PFM images reveal a non-piezoelectric signal from the topographical pillars and a clear piezoelectric signal from the matrix. This suggest that topographical pillars are NiO and the flat matrix corresponds to ZnO. C-AFM confirms this behavior: the topographical pillars are non-conductive and the matrix is semi-conducting. Local I-V measurements also well agree with SPM images. We have successfully obtained a ZnO/NiO co-deposited thin film with good nanoscale electrical properties.

1. O. Nakagawara et al., Materials Research Society 2015 Fall Meeting NN18.05.

Figure 1: SEM (Grey area correspond to ZnO, White pillars correspond to NiO), AFM, PFM and C-AFM images