Amplitude- and phase-resolved optical near fields of propagating surface plasmons on extended and nanostructured thin films

T. V. A. G. de Oliveira † , J. Dorfmüller, R. Vogelgesang, K. Kern

Max-Planck-Institute for Solid State Research, D-70569 Stuttgart, Germany† New Address: Self-Assembly Laboratory, CIC nanoGUNE Consolider, E-20018 San-Sebastián, Spaint.oliveira@nanogune.eu

In conventional implementations of apertureless Scanning Near-field Optical Microscopes, sample excitation is accomplished through the same lens used to collect backscattered near field signals [1]. The main advantage of this illumination scheme is that excitation and collection foci share the same volume, thus facilitating illumination alignment procedure. High intensity of detected fields and excellent resolution are among the qualities of this solution. Many interesting optical phenomena, however, cannot be exploited with this type of excitation. In plasmonics, for instance, this solution is limited to the investigation of SPR in small particles – also known as particle plasmons. If the structure supporting SPR is too large compared to the beam focus waist, propagation of SPP prevails in detriment of cavity resonances. Consequently, as the map of near fields is acquired always in the exact position where SPP is coupled, the interpretation of the resulting image gets complicated [2].Here I present a new illumination scheme, wherein sample illumination is completely independent of the collection lenses. Light excites the structures of interest through the glass substrate supporting them. Specifically, I have investigated the capability of aSNOM in the study of Propagating Surface Plasmons on extended and structured thin films deposited on glass substrates. Exploiting the strong analytical potential of the instrument, near-field phase and intensity maps of the local fields has allowed the direct measurement of wave vectors associated with the propagating SPP on thin films, as seen in Figure 1 [3].

References:

[1] Hillenbrand, R. PhD Thesis, Technische Universität München, 2001.[2] Vogelgesang, R.; Dorfmüller, J.; Esteban, R.; Weitz, T.; Dmitriev, A.; Kern, K. Phys. Stat. Sol. (b), 245, p. 2255-2260, 2008.[3] de Oliveira, T. V. A. G. Diploma Thesis. Universidade Federal de Santa Catarina, 2008.

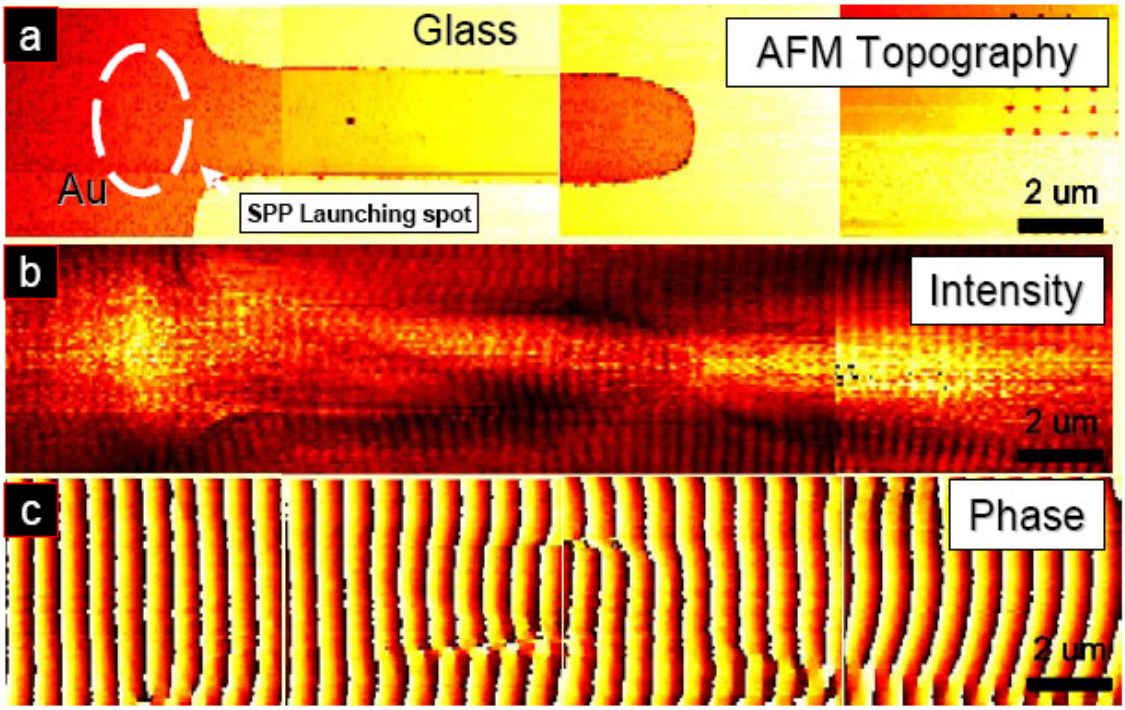

Figure 1. SPP propagation on metal stripe. In (a) the topography image, wherein darker regions represent higher features. SPP is coupled to the metal surface on the region indicated by the white circle. Optical near-field amplitude and phase are depicted in (b) and (c), respectively. The wavelength in vacuum of the light used was = 820nm.