# Conductive Atomic Force Microscopy Investigations of Organic Thin Films

*A. Pavitschitz[1], C. Teichert[1], I. Beinik[1], M. Kratzer[1], S. Radl,[2] T. Griesser[2], W. Kern[2]*

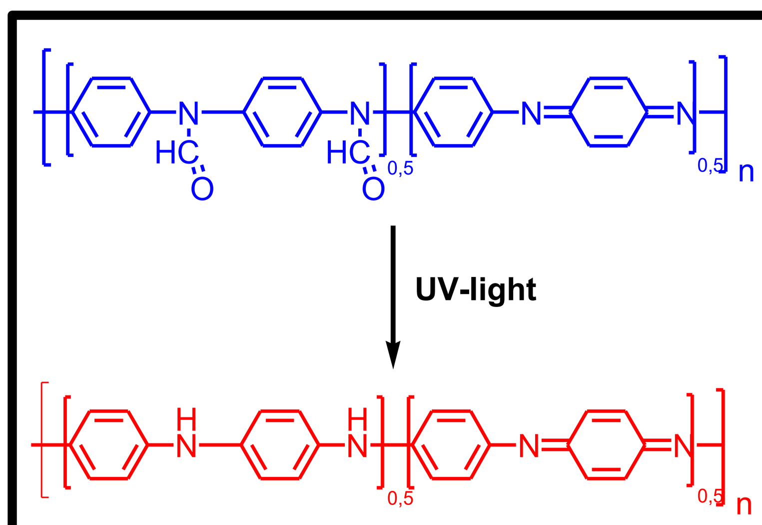
*[1]Institute of Physics, Montanuniversität Leoben, Franz Josef Strasse 18, 8700 Leoben, Austria; [2] Institute of Chemistry of Polymeric Materials, University of Leoben Franz Josef Strasse 18, 8700 Leoben, Austria*

## Introduction

Organic materials are already used in electronic devices as dielectrics, semiconductors, and conductive materials. The device performance depends on the electrical properties and the surface morphology of the organic thin film. Especially, UV sensitive polymers allow a patterning and a functionalization of films in organic electronics. [1]

In this study, conductive atomic force microscopy (C-AFM) [2] was used to investigate the UV sensitive conductive polymer polyanilin (PANI). C-AFM proved a increase in conductivity in the polymer film after UV- exposure and protonation with HCl.

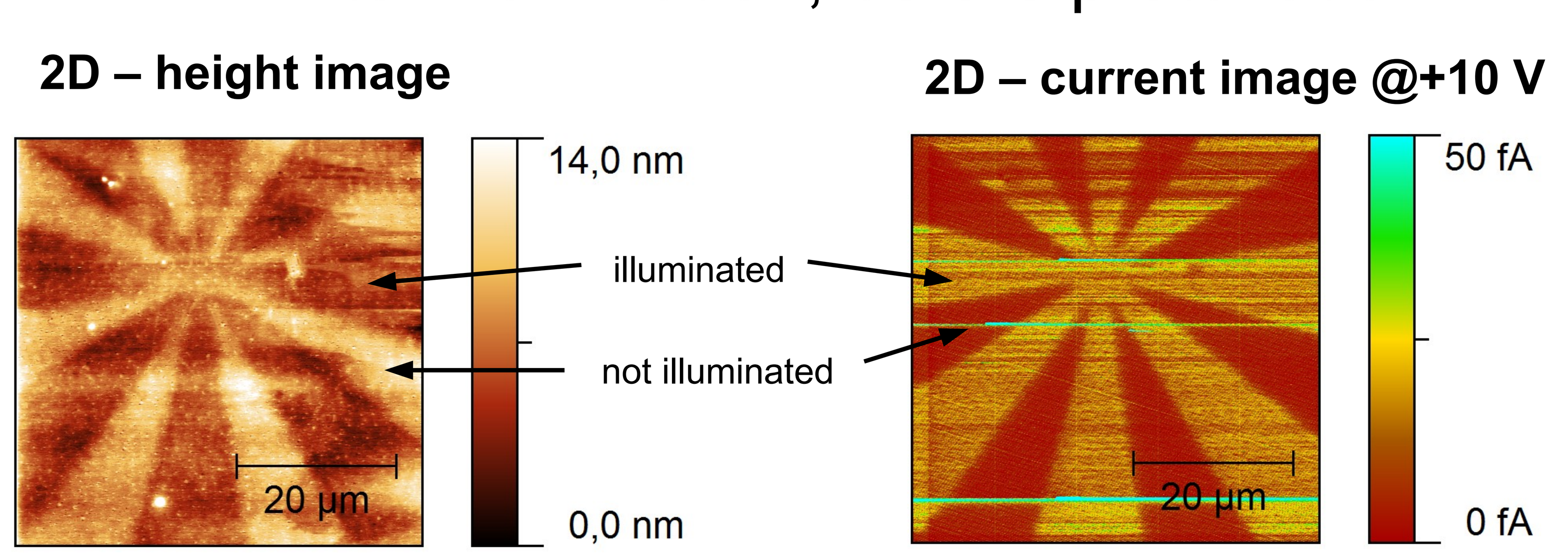
## Samples



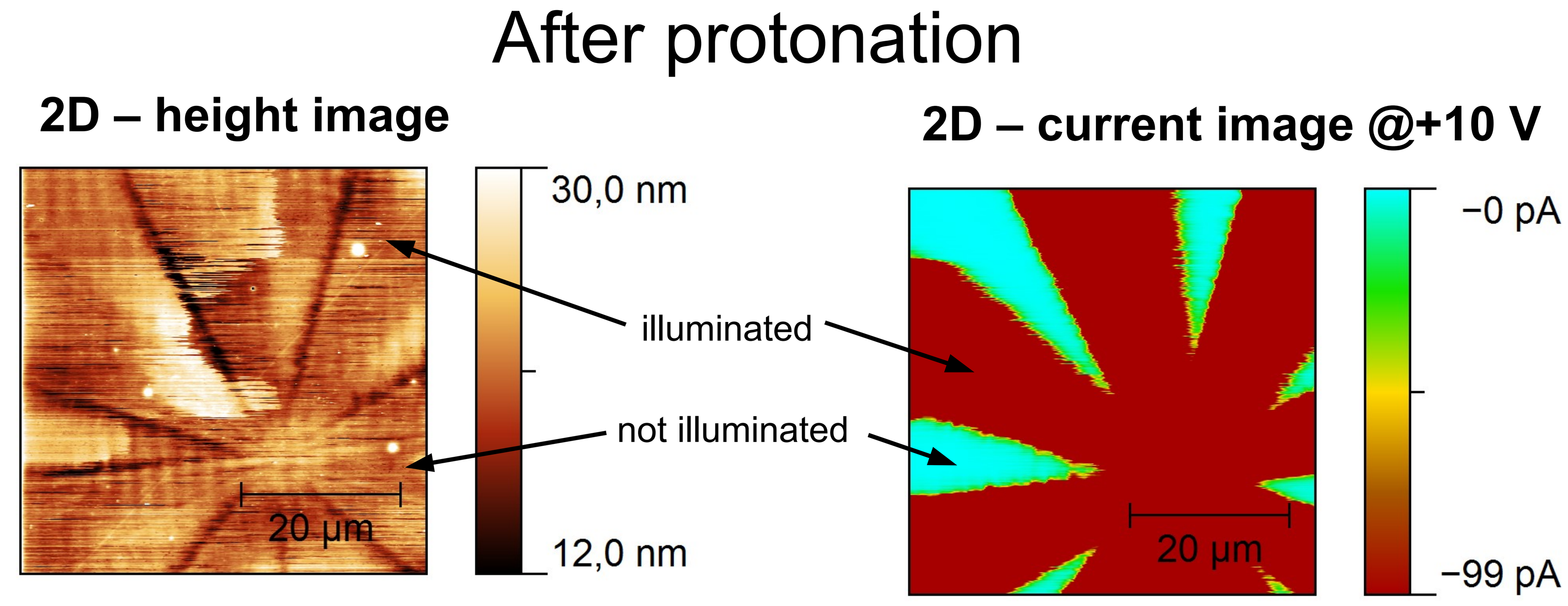

The polymer layers were prepared by spin coating on Au/glass and ITO. The samples were illuminated through a mask with UV – light (260 - 320 nm) and protonated by exposure to HCl vapor.
In the micrometer scale contact mask, the center of sun rays is transparent.

## Results PANI on ITO

### After illumination, before protonation




### After protonation



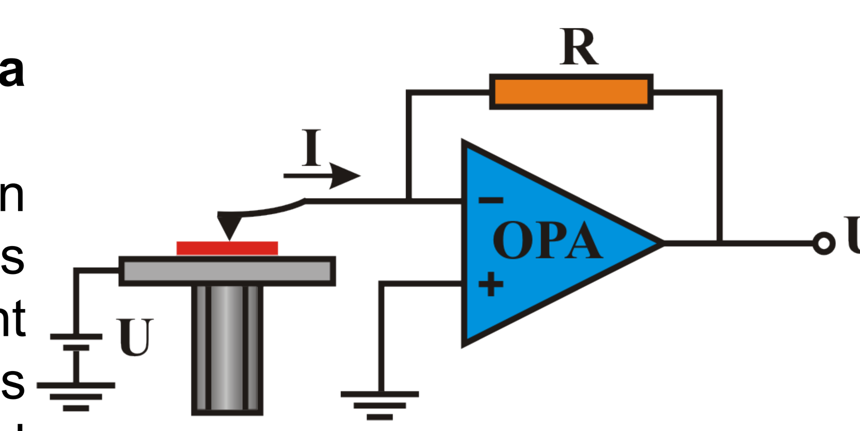

**Topography:**
An effect of exposure to UV radiation can be seen on the height images where the illuminated areas are about 10 nm lowered. The exposure to HCl vapor has a disadvantageous influence on the height imaging which may be caused by a liquid film on the surface. The RMS roughness increases from 2.3 nm to 3.4 nm.

**Current:**
A change in conductivity can be seen already after illumination, before protonation. But the shift in conductivity of the illuminated areas by about 20 fA is at the noise level of our C-AFM, so the positive value of the current is not reliable. After protonation, the current - at a applied Bias of +10 V - on illuminated areas is increased to about -100 pA. The non illuminated areas are not influenced by protonation in their conductivity.

## Experimental Setup

**C- AFM:**

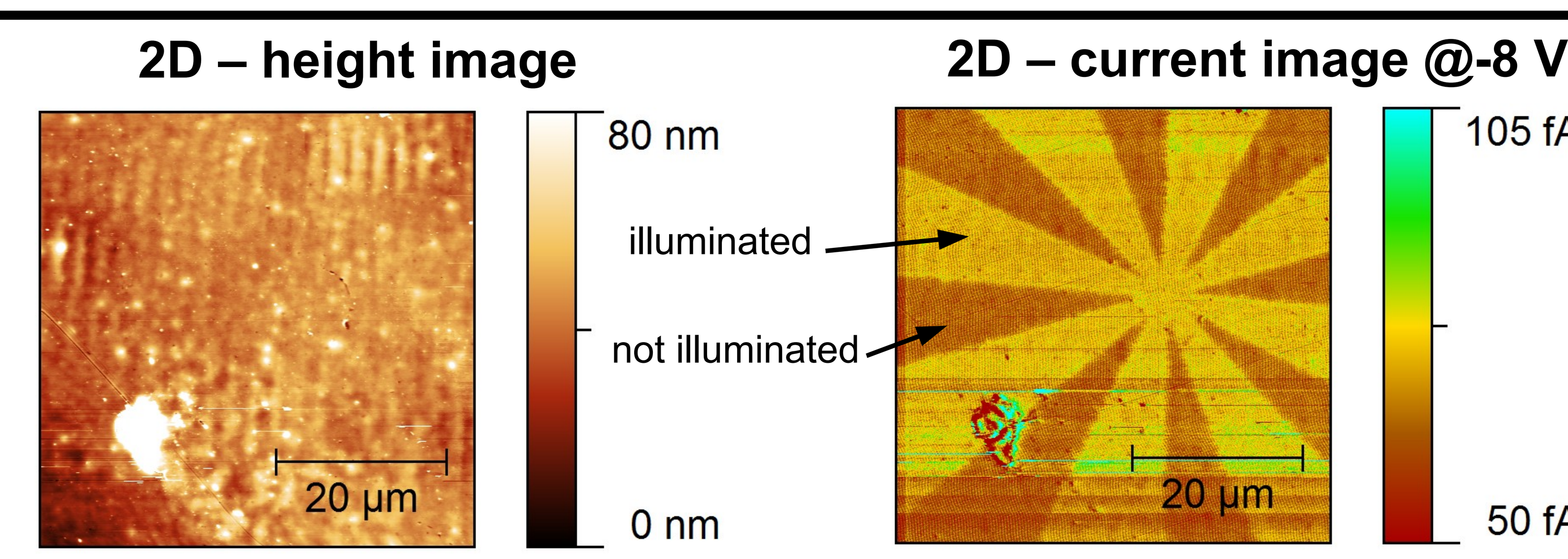
**Digital Instruments Nanoscope IIIa Multimode AFM**




In C-AFM a voltage is applied between the tip and the sample, the current is measured simultaneously with the height signal. (C-AFM) allows simultaneous mapping of the morphology and the local film conductivity on the nanometer-scale. The details of carrier transport can be explored by measuring local current-voltage (I/V) curves. [2]

**Probes:**
- TiN coated tips for C- AFM, force constant 0,003 - 0,13 N/m, r = 35 nm

## Results PANI on Au/glass




The height image shows an uneven surface with heights up to 80 nm and an RMS roughness of 11.8 nm. There is no influence of illumination on the surface morphology visible. In the current image, a change in conductivity after illumination and protonation is clearly detected. For an applied voltage of -8 V, the current in the illuminated areas was estimated to be about 50 fA higher than in the non-illuminated areas.

## Discussion and conclusion

- On both (Au/glass and ITO) substrates, a small but clear increase in conductivity of PANI was observed after UV exposure.
- Subsequent protonation was found to further increase the conductivity by three orders of magnitude a while the conductivity of the non-illuminated is not altered.
- C-AFM has been proven to be a reliable technique to study these effects.

## Acknowledgement

Support by the FWF projects S9702, S9707 and P19636 (NFN “Interface controlled and functionalized organic thin films”) is acknowledged.

## Literature

[1] A. Lex, et al., Chem. Mater. 2008; 20: 2009-2015
[2] S. Kremmer, et al., Surf. Interface Anal 2002; 33: 168-172

## Contact

**Andreas Pavitschitz**, University of Leoben, Austria,
e-mail: andreas.pavitschitz@stud.unileoben.ac.at
**Christian Teichert**, University of Leoben, Austria,
e-mail: teichert@unileoben.ac.at
www.unileoben.ac.at/~spmgroup