Adsorption of carboxyphenyl-substituted porphyrin on titanium dioxide

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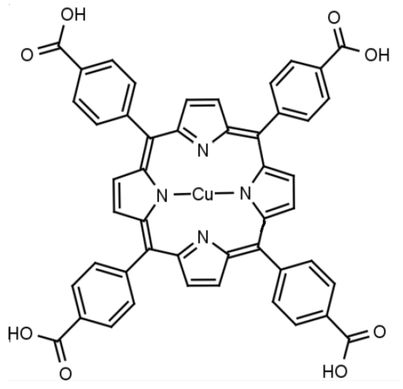
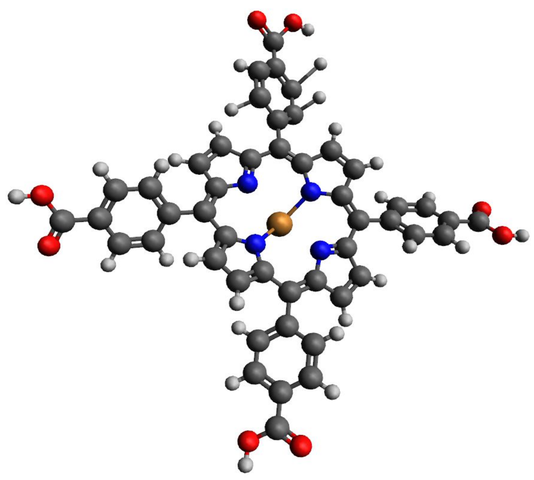
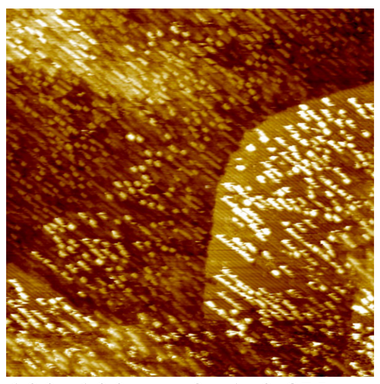
Abstract

Understanding and engineering the molecule-substrate interaction is crucial for technologies relevant for dye-sensitized solar cells (DSSC). In the presentation we present results of the studies into the influence of substrate orientation on the molecular structure of the thin porhpyrin layer. Porphyrins were one of the first sensititzers used in dye-sensitized light harvesting applications[1]. We have used carboxyphenyl-substituted porphyrin, tetrakis(4-carboxyl-phenyl)porphyrin cooper(II) (CuTCPP) The presence of anchoring carboxylic group plays major role in the adsorption as well as the electron transfer processes[2]. With use of scanning tunnelling microscopy (VT-STM) and analyze CuTCPP /TiO_2(110) and CuTCPP/TiO_2(011) systems. The measurements were carried out at low temperatures in order to immobilize molecules and allow for high-resolution structural characterizations.

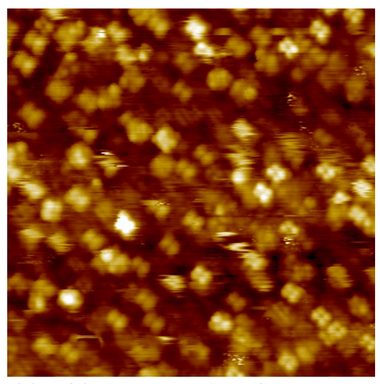




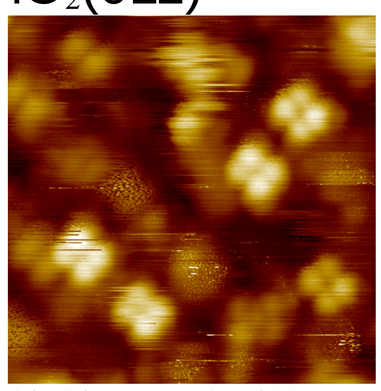
CuTCPP/TiO_2(011)



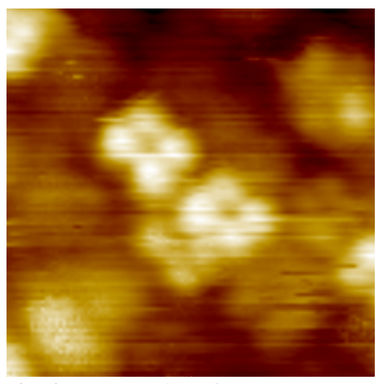
100x100nm, 3pA,0,8V



40x40 nm, 5pA, -3V

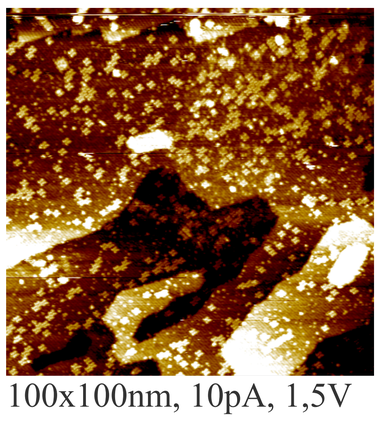


10x10 nm, 5pA, -3V

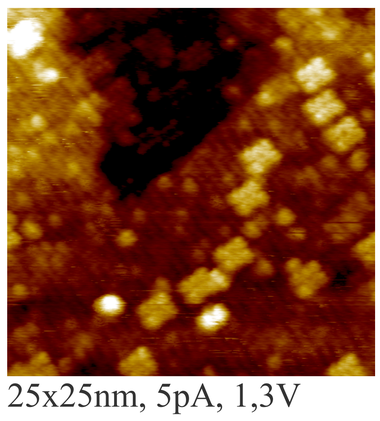


6x6nm, 5pA, -3V

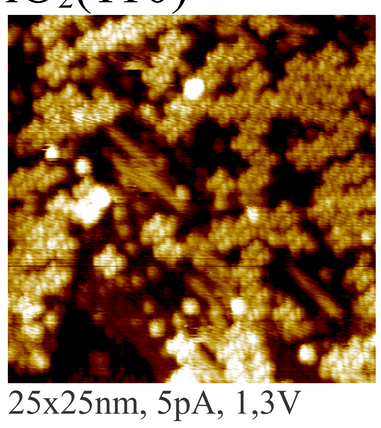
CuTCPP/TiO_2(110)



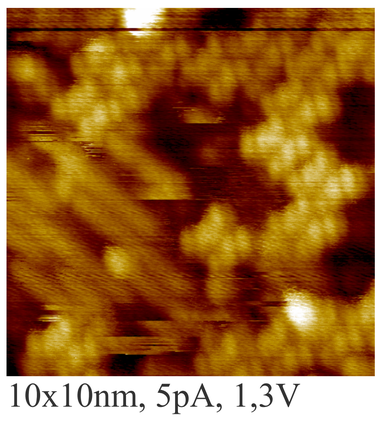
100x100nm, 10pA, 1,5V



25x25nm, 5pA, 1,3V



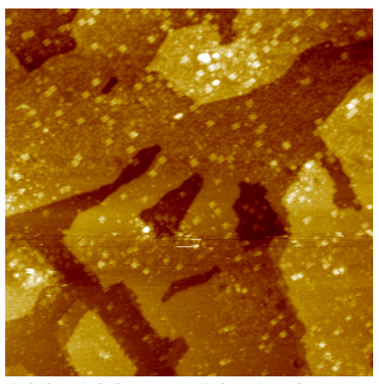
25x25nm, 5pA, 1,3V



10x10nm, 5pA, 1,3V

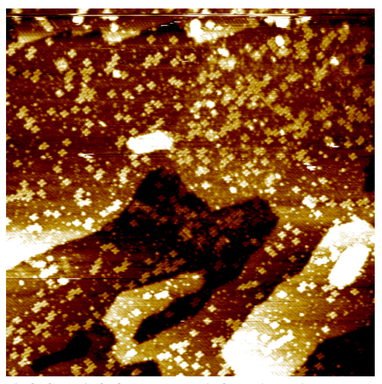
Structure dependence on the coverage

10 min



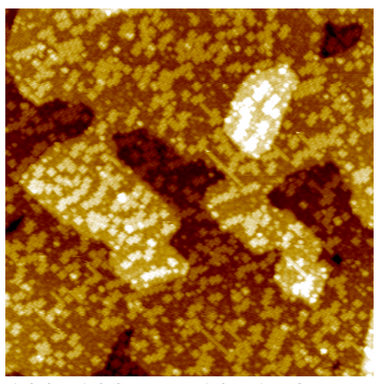
100x100 nm, 10pA, 2 V

60 min



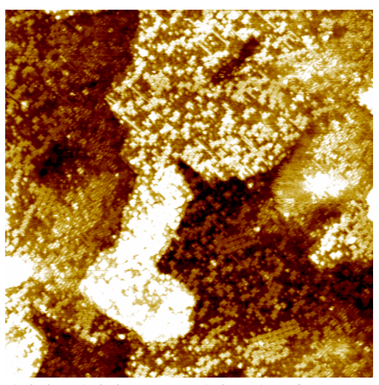
100x100 nm, 10pA, 1,5 V

90 min



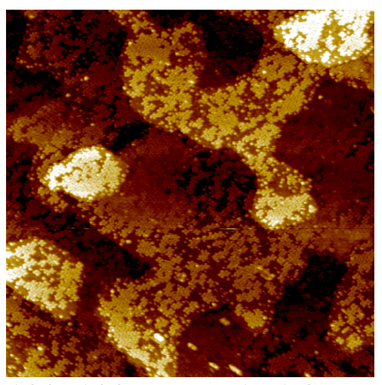
100x100 nm, 10pA, 2 V

120 min



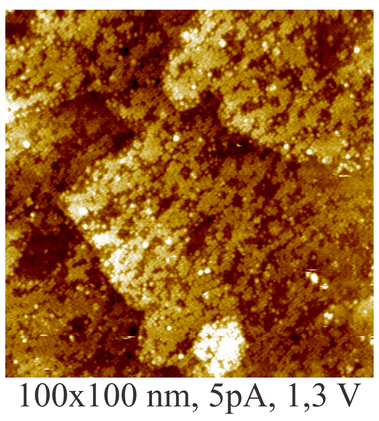
100x100 nm, 10pA, 2 V

180 min



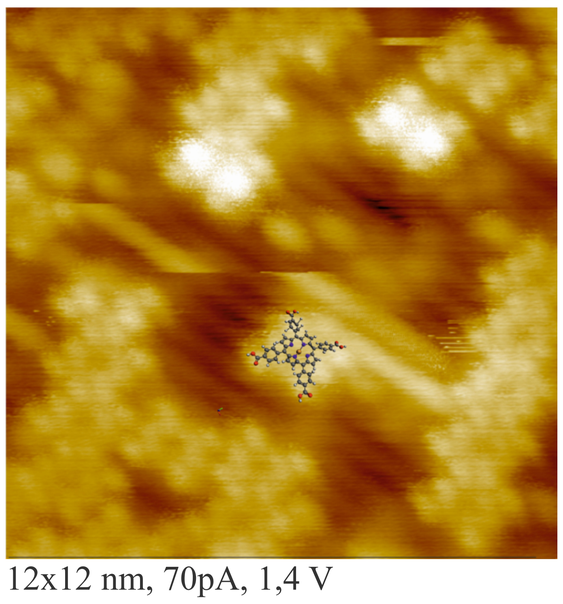
100x100 nm, 5pA, 1,3 V

270 min

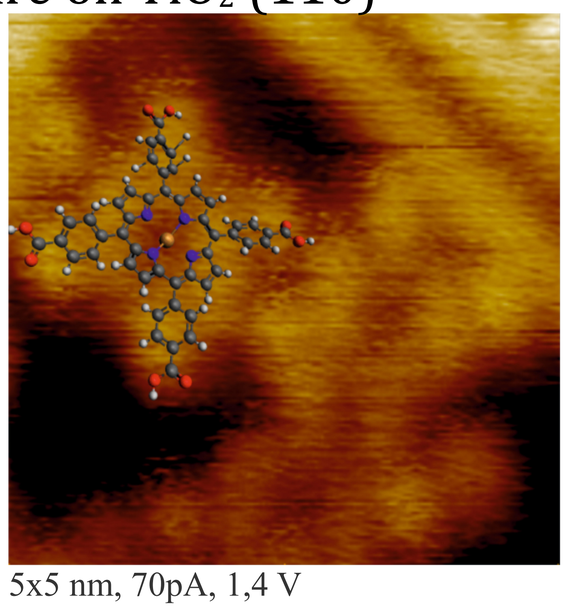


100x100 nm, 5pA, 1,3 V

Molecular structure on TiO_2 (110)

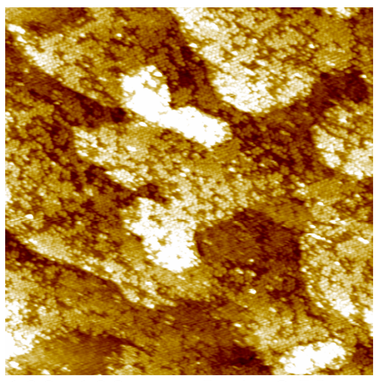


12x12 nm, 70pA, 1,4 V

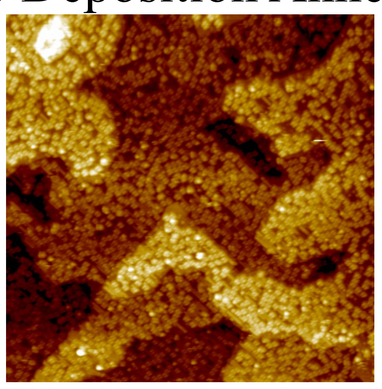


5x5 nm, 70pA, 1,4 V

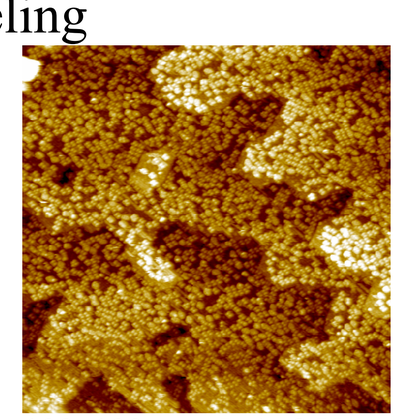
Post-Deposition Anneling



100x100 nm, 5pA, 2 V



100x100 nm, 5pA, 2 V



100x100 nm, 5pA, 2 V

Conclusions

CuTCPP/TiO_2(011)
- No regular pattern observed

CuTCPP/TiO_2(110)
- Molecules are bound strongly to the surface
- Ordered in chain
- The carboxylic groups are bound with oxide rows
- Molecules are still bound to the surface after post-depostition annealing above evaporation temperature
- We have observed a saturation of surface coverage

Outlook

The further investigation CuTCPP /TiO_2(110) and CuTCPP/TiO_2(011) systems with using carboxyphenyl-substituted porphyrin with one and two carboxyilc groups.

Acknowledgement

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References:
[1] A. Hagfeldt, G.Boschloo, L. Sun et al., Chem. Rev. 110,6595-6663, (2010).
[2] A. Karhiravan, R. Renganathan, Journal of Colloid and Interface Science 331, 401-407, (2009)