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Investigation of the growth of thin Ionic Liquid films on Au(111) and HOPG

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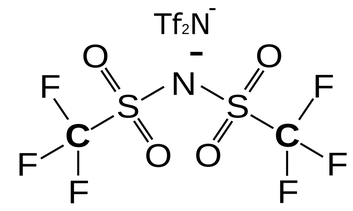
1. Motivation

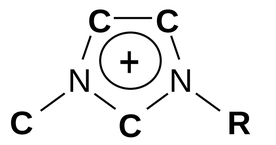
Room-temperature ionic liquids (RT-ILs) have recently attracted much attention as new organic solvents and functionalized materials. As ionic liquids have very low vapour pressures at room temperature they can be employed in vacuum experiments either as fluid substrates or as solvents. At elevated temperatures it is possible to evaporate them in UHV and deposit thin films of ionic liquids. With it the "solid liquid interface" is accessible. We investigate the interface of Au(111) and HOPG with thin films of [OMIm]Tf_2N and [EMIm] Tf_2N by applying **metastable induced electron spectroscopy (MIES) and UPS (He I)** .
In addition we investigate the behaviour of silver evaporated on [EMIm]Tf_2N monolayers on HOPG.

2. Experimental



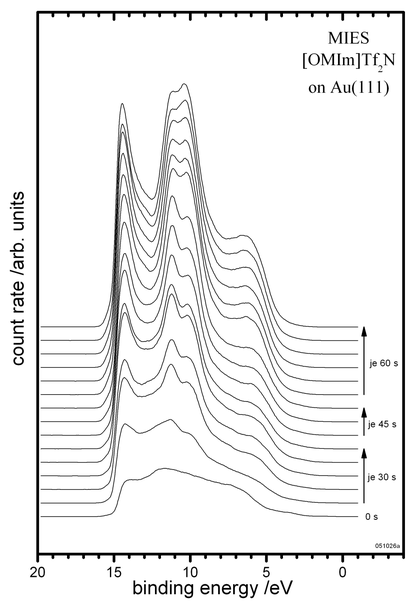
UPS: He I (21.2 eV) and He II (40.8 eV)
MIES: He* 2^3S (19.8 eV)
UHV systems with base pressure < 2.0×10^{-10} Torr
Substrates: **Au(111)** and **HOPG**
Ionic Liquids from IoLiTec: **[**1-**R**-3-**M**ethyl-**Im**idazolium**]Tf_2N**
(R = Ethyl**, O**ctyl**)**

The sample surfaces were prepared by vapour deposition of the ultrapure Ionic Liquids onto the substrates.

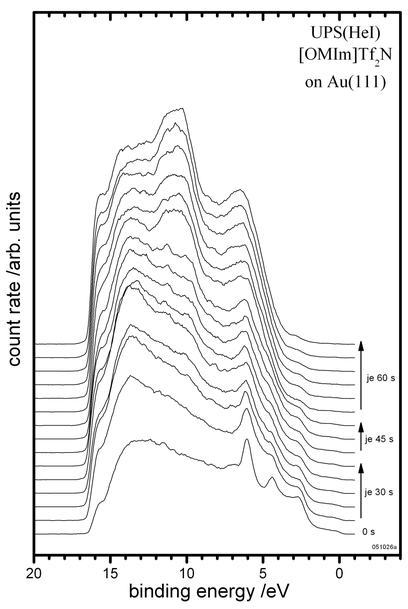


[RMIm]+

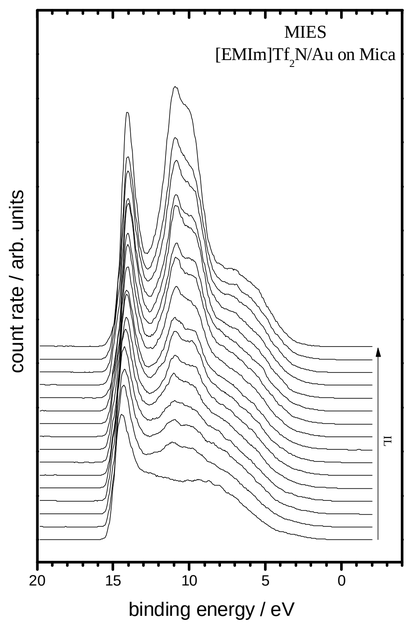
3. [OMIm]Tf_2N thin films on Au(111)

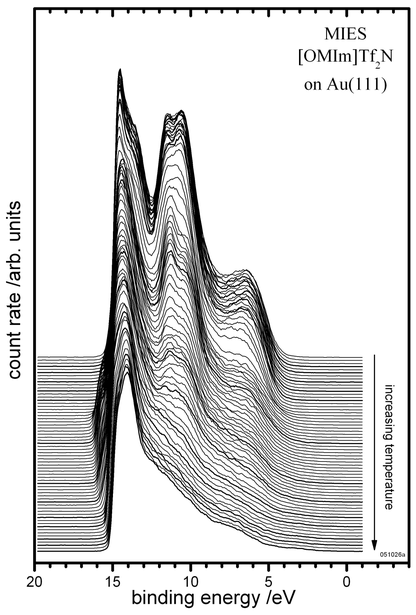


- in MIES: [OMIm]Tf_2N spectra for low coverage (below 1ML) resemble those for [EMIm]Tf_2N
- for high coverage (> 1ML) peaks around 7 eV (cation), 11 eV and 12 eV (F2p) show an intensity change during IL exposition
- after completion of the 2nd layer, spectra resemble those for bulk [OMIm]Tf_2N
- in UPS: linear increase of the IL peaks during IL exposition, no differences compared to the bulk spectra
- during heating change of the "bulk" like [OMIm] spectra to the [EMIm] like spectra is visible

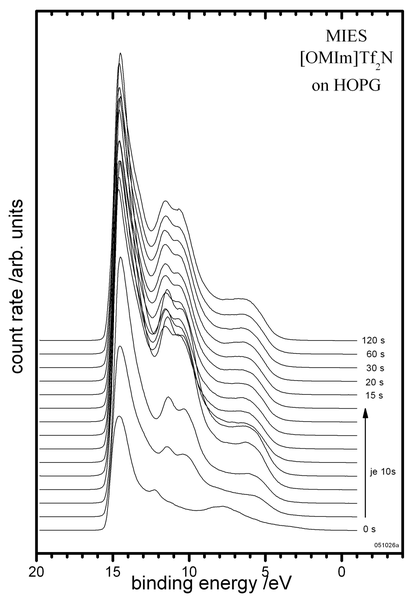


A [EMIm] like spectrum for the 1. layer is an indication for a more flat adsorption of the cation. The increase of the peak around 7eV and a change of the F2p peaks is an indication of a reoriantation of the cation in the 2. layer (alkyl chains protrudes to the vacuum)

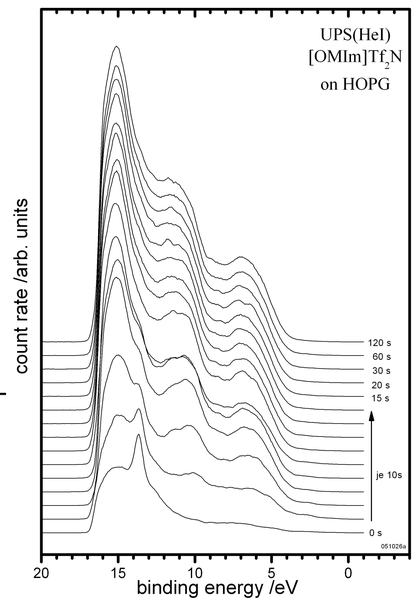


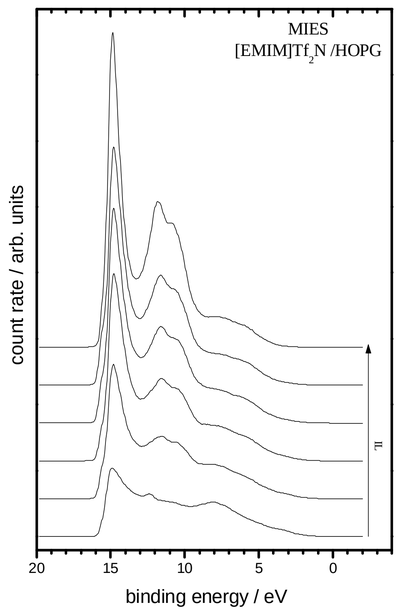


4. [OMIm]Tf_2N thin films on HOPG



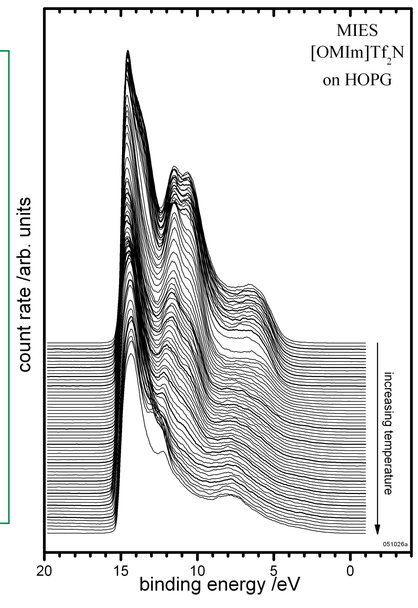
- In MIES: peaks around 7 eV, 11 eV and 12 eV show only a small intensity change during IL exposition
- In comparison to the data for thick films → reorientation of the IL after a larger exposure compared to Au(111)
- in UPS: linear increase of the structure at 7eV and 12eV





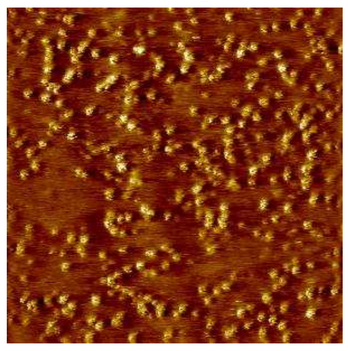
A [EMIm] like spectrum for the first layers (~3L) is again an indication for a more flat adsorption of the cation.

The reorientation in the second layer does not take place. This could correlate with a stronger adsorption of the cation on the HOPG, which is in good agreement with the heating measurement.



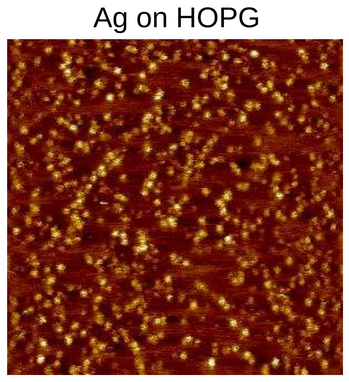
5. Ag on [EMIm]Tf_2N thin films

Ag and [EMIm]Tf_2N on HOPG



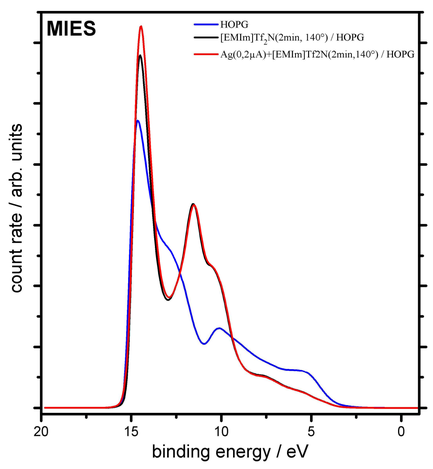
resolution: 100nm x 100nm

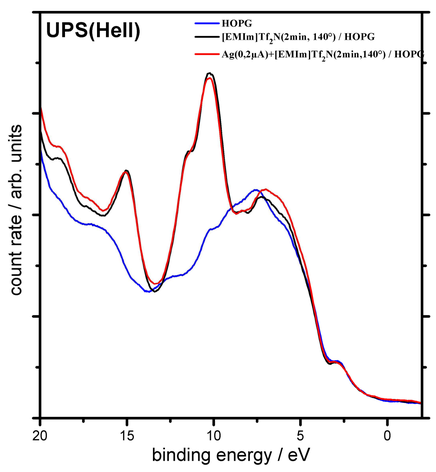
Ag on HOPG



resolution: 100nm x 100nm

The particle diameters in both cases are between 2-5nm.
The particle heights of the Ag particles in [EMIm]Tf_2N are larger than without IL.





No differences between pure [EMIm]Tf_2N spectra and Ag in [EMIm]Tf_2N.
This indicates that the Ag particle is covered completely with the Ionic Liquid.

6. Summary

The orientation of the alkyl chains probably change after completing the first monolayer of [OMIm]Tf_2N on Au(111).

→ alkyl chain protrudes from surface [1]

In comparison to Au(111) the reorientation on HOPG starts a larger exposure.

The IL has an effect on the silver particle size. Evaporated into the Ionic Liquid the particles become larger.

7. References

[1] T. Ikari, A. Keppler, M. Reinmöller, W.J.D. Beenken, S. Krischok, M. Marschewski, W. Maus-Friedrichs, O. Höfft, and F. Endres; e-Journal of Surface Science and Nanotechnology, accepted

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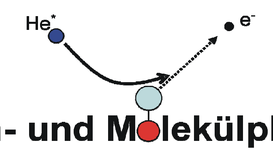

Atom- und Molekülphysik an Oberflächen