Chemical tuning as a new parameter to control HIOS thin-film growth

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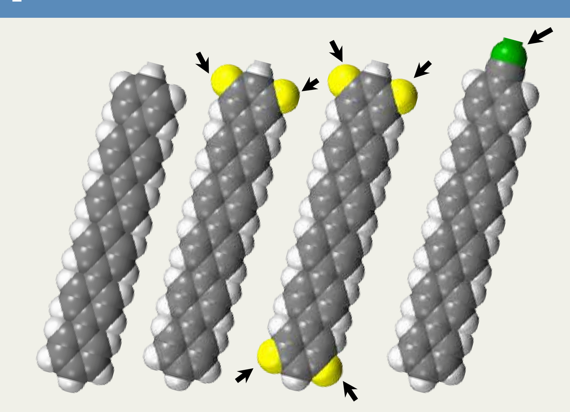
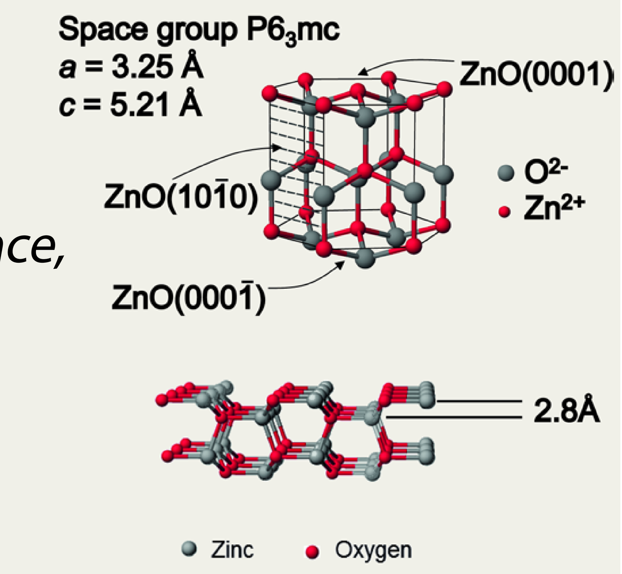
Growth control beyond substrate temperature and growth-rate



6P 6P-F2 6P-F4 6P-CN

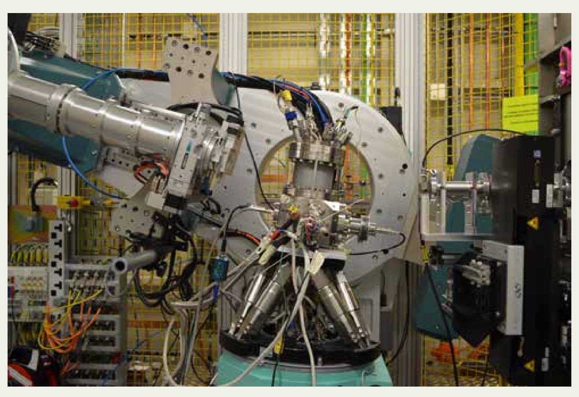
Chemical tuning of sexiphenyl (6P) → *incorporation of local dipole moments (tunable strength)* → *changes in intermolecular electrostatic interactions*

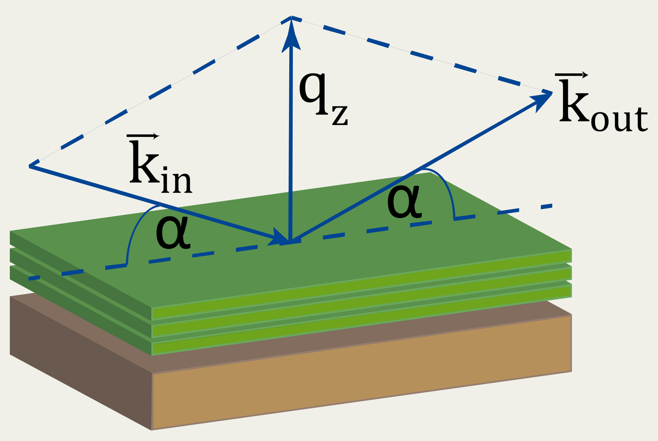
*We study the growth of 6P and its derivatives on ZnO (10**1**0) as a model HIOS system.*
The beneficial optical properties of 6P, e.g. fluorescence, are not affected by the chemical tuning.
The deposition of the molecules was performed by OMBD in UHV (~10^{-10} mbar) conditions.



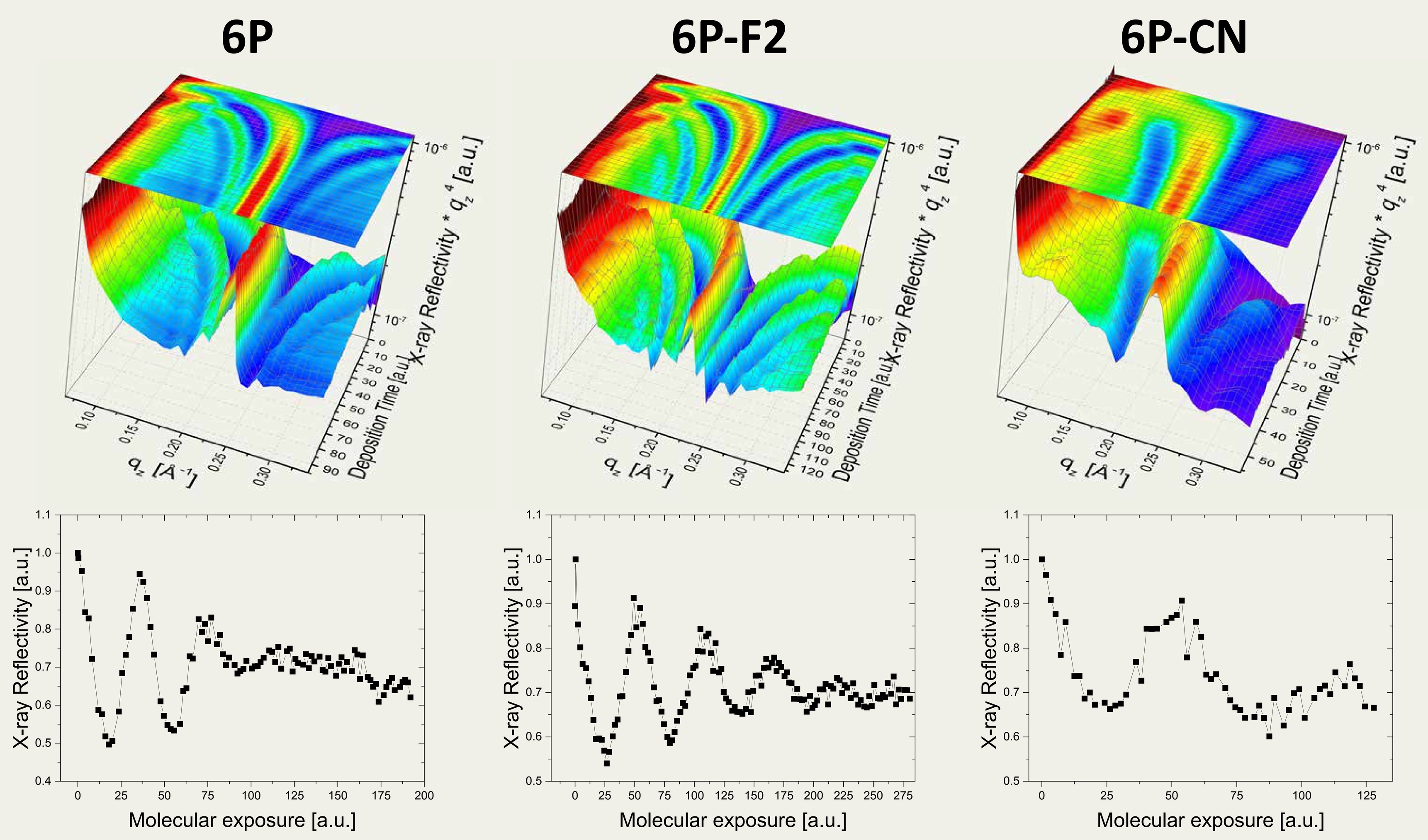
Watching the growing thin-film

We use synchrotron radiation sources to study the temporal evolution of the intensity of the reflected X-ray beam (XRR) in situ and in real-time.

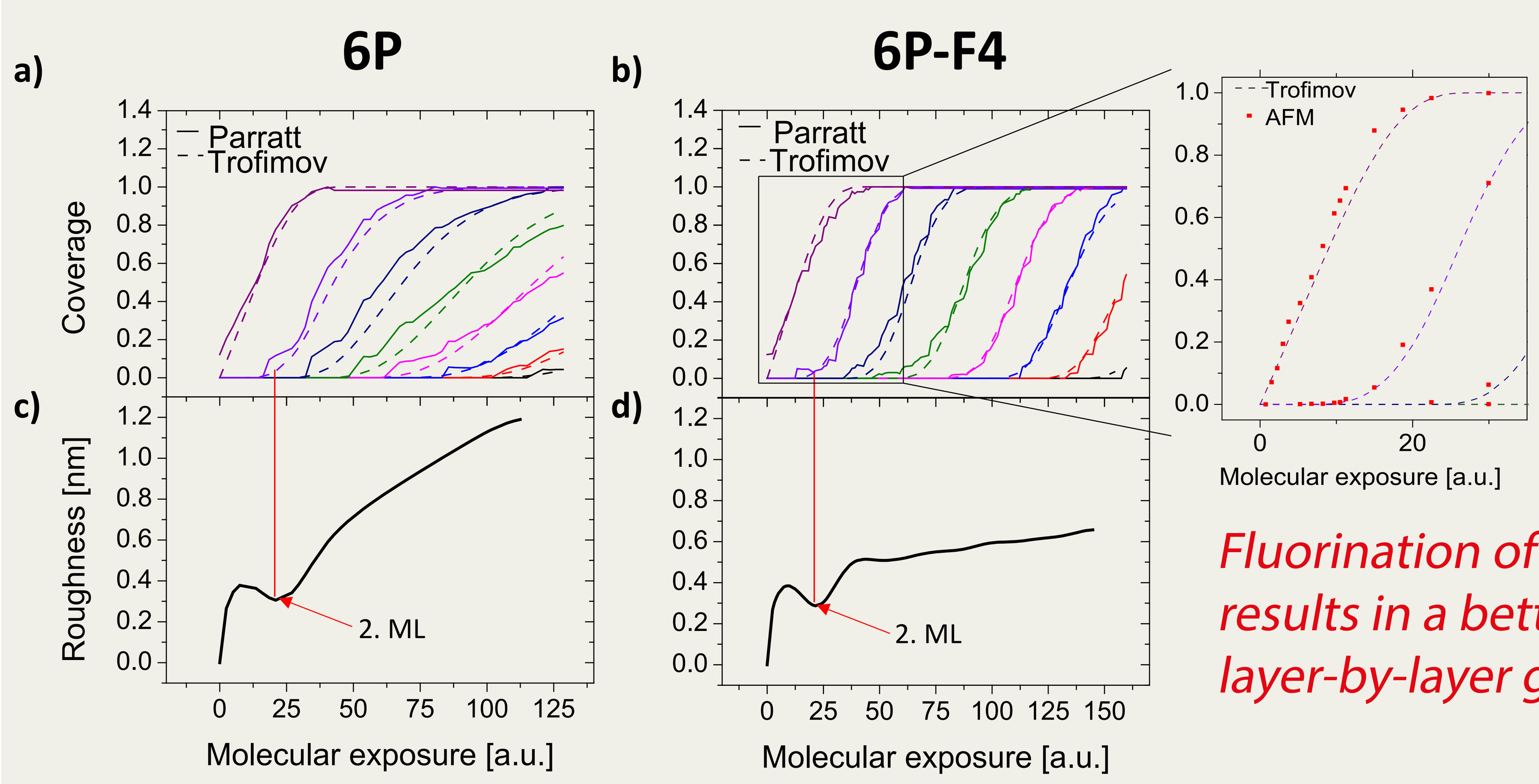




Fluor-induced surface smoothing



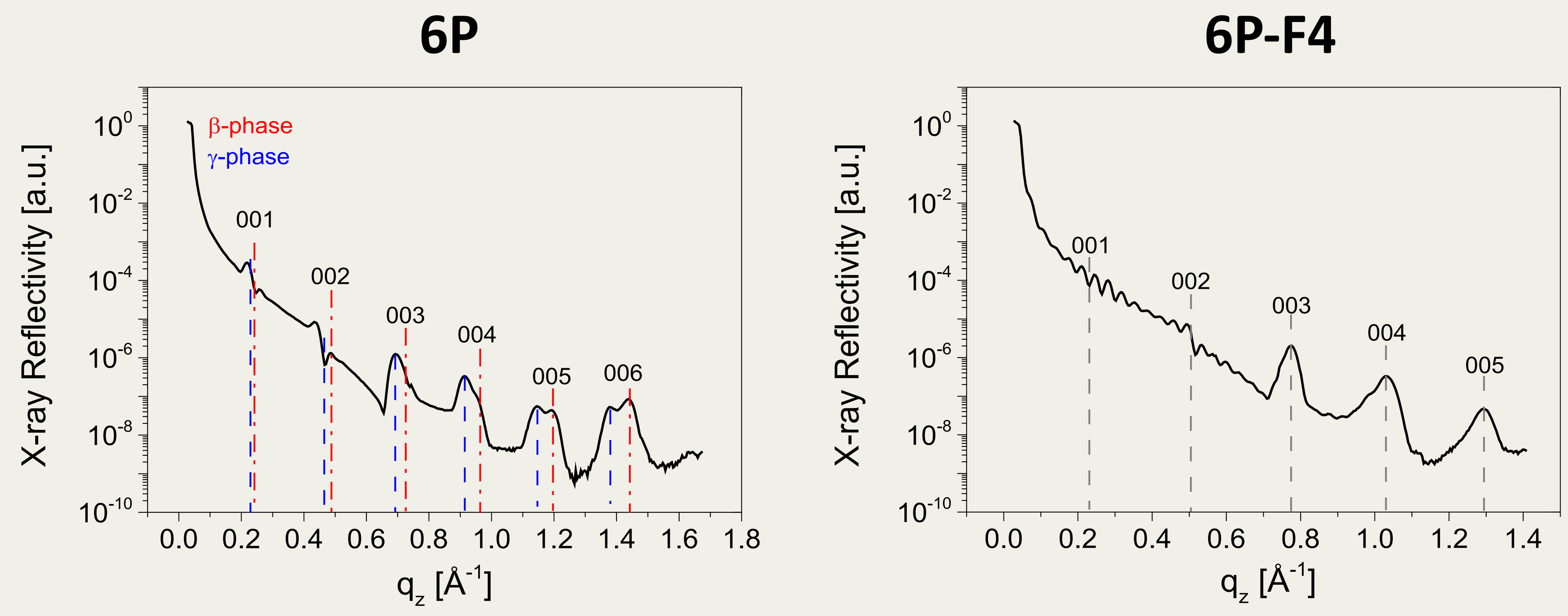
The X-ray reflectivity data at fixed q points (e.g. at the Anti-Bragg point) exhibits growth oscillations.
Damping of oscillations is a measure for the surface roughening.
By applying analytical models [1-4] we can extract the growth-mode and roughness evolution and compare with AFM data.



Fluorination of 6P results in a better layer-by-layer growth.

Crystal phase purification

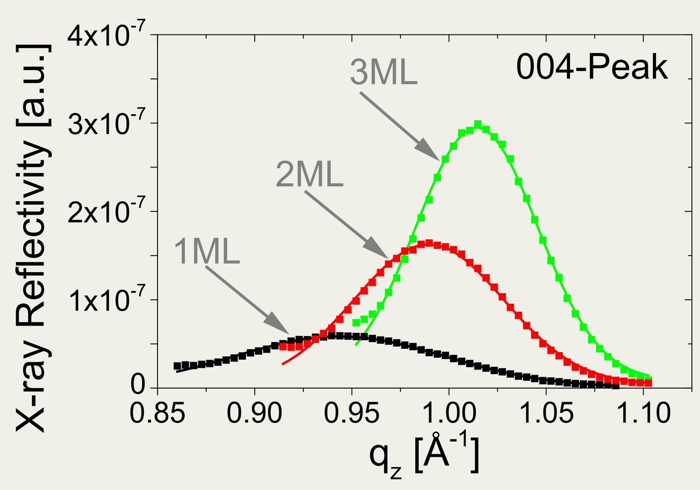
6P and the derivatives prefer an almost standing upright configuration.
The crystal quality of all films is good (Bragg reflections up to the 6th order in the out-of-plane direction).



*As on other substrates 6P grows in two phases on ZnO (10**1**0). The phase-content is temperature dependent.*
No indication for a second crystal-phase was found for any of the derivatives of 6P.
Thus, chemical tuning of 6P through -F and -CN groups leads to a crystal-phase purification.

Surface induced phases

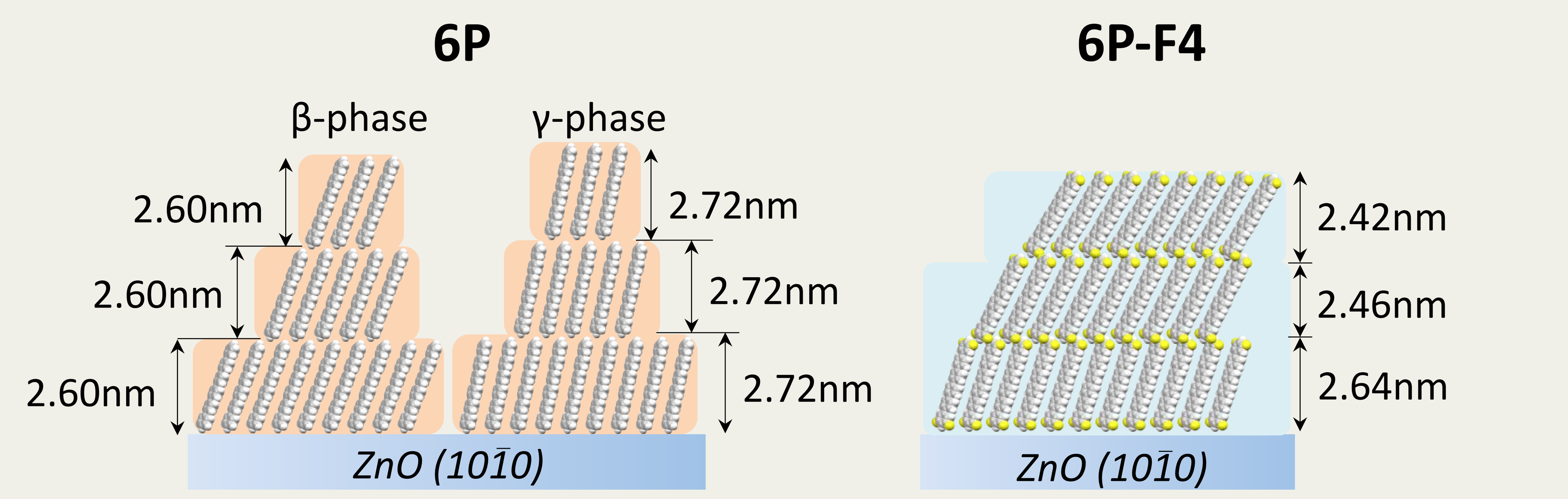
6P-F4



	d [nm]
1 ML	2.64 ± 0.12
2 ML	2.46 ± 0.06
3 ML	2.42 ± 0.03

The exact molecular orientation, i.e. the tilt angle, is also chemically tuned.
For 6P derivatives we find a gradual change of the (00l) Bragg reflections with increasing film thickness.
The reason for the peak shift is a surface induced structure that is different from the bulk.
Interlayer transport is correlated via the Ehrlich-Schwoebel barrier with molecular tilt angle [5].

Small changes - Big impact



Chemical tuning presents a promising new strategy to control organic thin-film growth.
We find a strong impact on the morphology and growth kinetics.
By rational incorporation of different functional groups into the building block of well-known molecules a design of HIOS interfaces is possible.

References

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