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Thin films of new superconducting materials

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- Superconducting thin films (grown by physical vapor deposition)
- New heterostructures with Fe-pnictides and Fe-chalcogenides
- Synthesis & characterization of functional interfaces

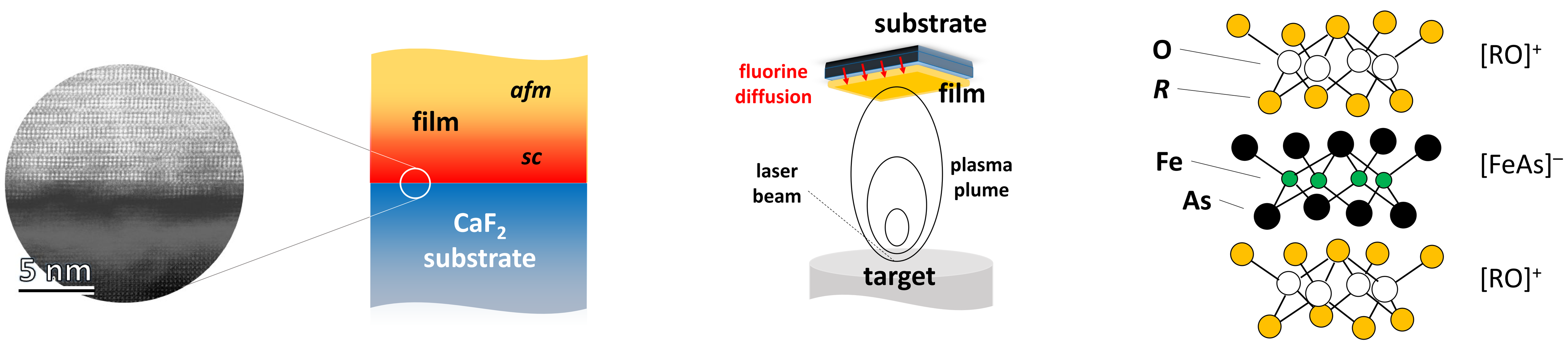
Thin film growth by physical vapor deposition

image: **plasma plume in UHV-PLD**

- For the growth of thin films and heterostructures of new superconducting materials we use state-of-the-art physical vapor deposition methods: ultra-high vacuum (UHV) pulsed laser deposition (PLD) and molecular beam epitaxy (MBE).
- **Fe-based superconductors:** We have recently succeeded in growing fluorine-substituted iron-oxypnictide ($SmO_{1-x}F_xFeAs$) thin films by *in-situ* PLD using CaF_2 substrates.

TEM collaboration: M. Sasase (Tokyo Institute of Technology)

Latest results: The fluorine diffusion gradient is responsible for a hybrid (sc/afm) bilayer structure.

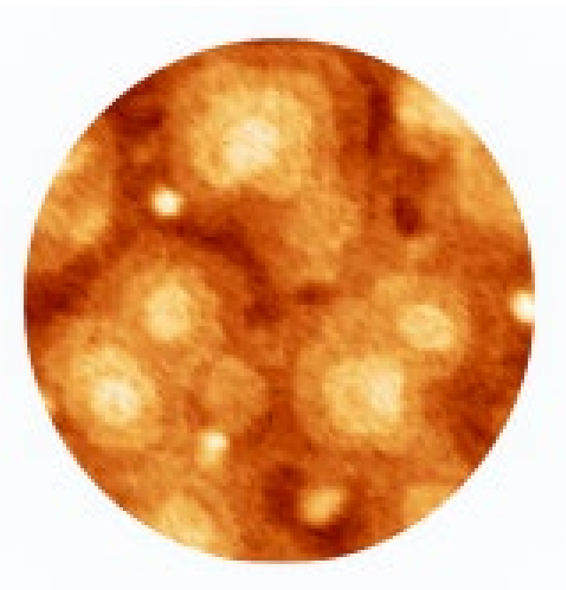


film/substrate interface

sc/afm hybrid iron-oxypnictide structure

diffusion process from the substrate during film growth

Fe-oxypnictide with ZrCuSiAs-type structure



Thin film characterization

image: **thin film surface morphology (AFM)**

- We are interested in the film growth modes and their tunability. For basic thin film characterization atomic force microscopy (AFM), reflection high energy electron diffraction (RHEED), X-ray diffraction (XRD) and X-ray reflectivity (XRR) are available.
- Electronic transport and magnetic properties of thin films and heterostructures are investigated at low temperatures and high magnetic fields.

Unconventional superconductors

Unconventional superconductivity (beyond BCS theory) can be found in many compounds and at interfaces.

The Fe-pnictides and –chalcogenides are one prominent and recent example of unconventional superconductors with high critical temperatures (~60 K for bulk samples). Spin fluctuations are dealt as main candidate responsible for Cooper pairing and for the superconducting order parameter the s± symmetry was proposed, which includes a sign change between different Fermi surface sheets. The extreme 2D limit (monolayers) and interface physics have, however, challenged a unified description.

We explore the future application potential of new electronic states occurring in engineered interfaces and heterostructures based on Fe-pnictides/-chalcogenides.