Physikalisch-Technische Bundesanstalt
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Thin-film growth techniques of molecule-based emitters for applications in single-photon metrology

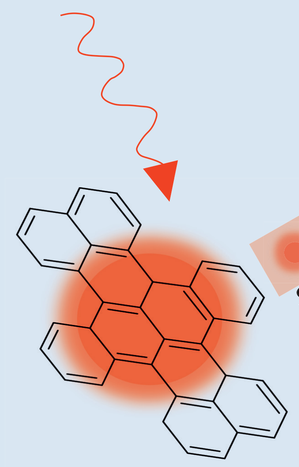
MOTIVATION

Polycyclic aromatic hydrocarbons (PAH), like dibenzoterrylene (DBT), are promising candidates to be used as emitters in single-photon sources for quantum optical applications [1].

Their absorption and emission in the near-infrared range correspond to the highest efficiency of Si-based detectors [2, 3].

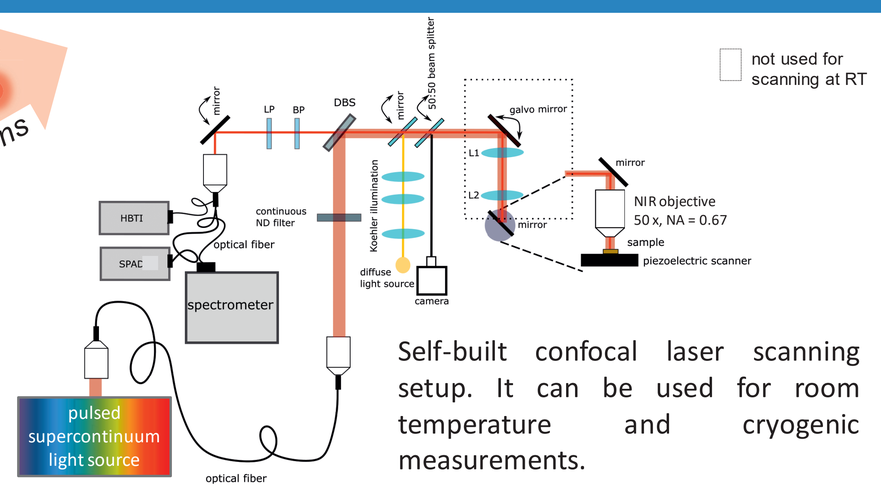
Simple, reproducible sample fabrication can overcome scalability issues.

Besides the encapsulation in anthracene (Ac) crystals, another approach is the embedment of DBT in fullerene conformations serving as a stabilizing environment



Single dibenzoterrylene (DBT) molecule

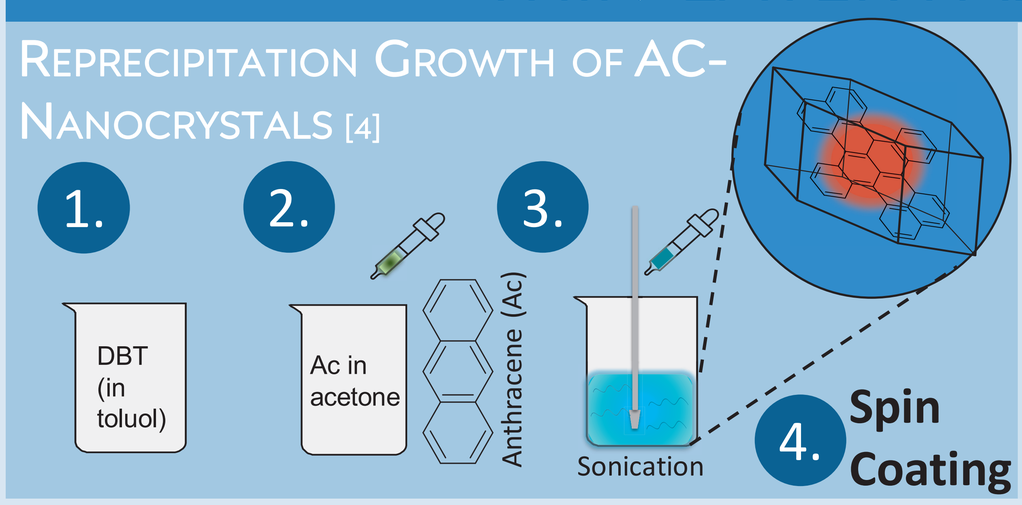
EXPERIMENT



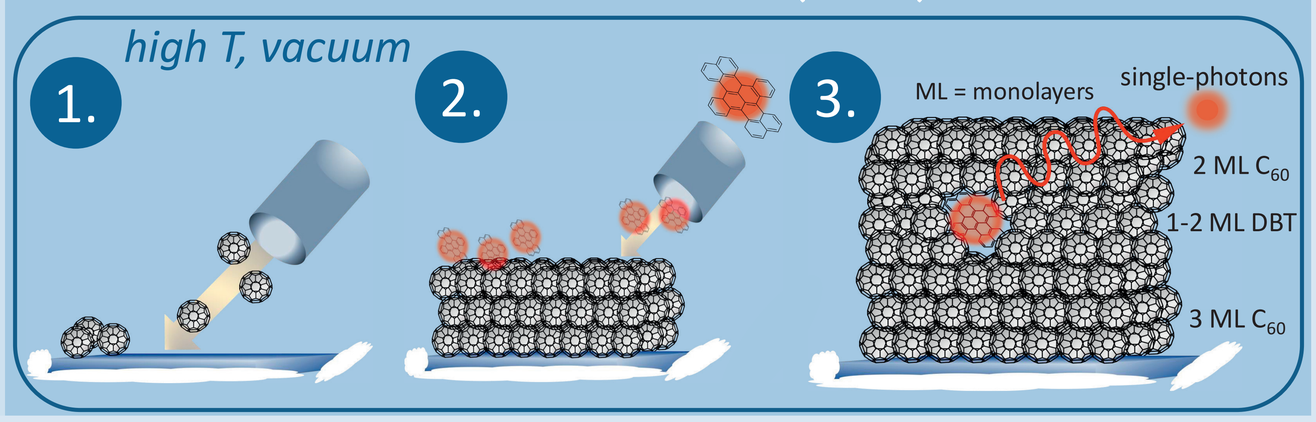
Self-built confocal laser scanning setup. It can be used for room temperature and cryogenic measurements.

THIN-LAYER FABRICATION TECHNIQUES

Reprecipitation Growth of AC-Nanocrystals [4]



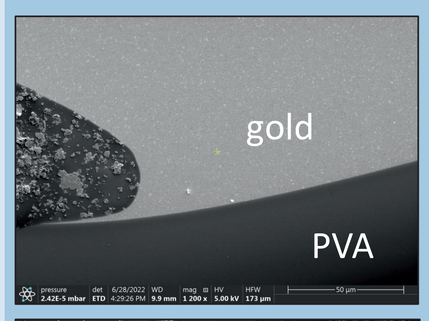
Organic Molecular Beam Epitaxy (OMBE)



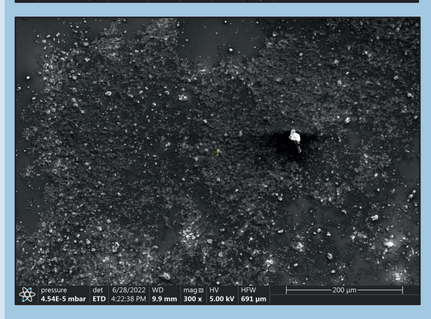
RESULTS

SEM Imaging of AC-Crystals

The anthracene-(nano)crystals are protected against thermal and oxygen diffusion by spin coating a 5 w% polyvinylalcohol (PVA)-layer on top. A 150 nm thin gold layer serves as a conductive underground.



SEM imaging was kindly done by Stefan Wolter, IHT TU BS.

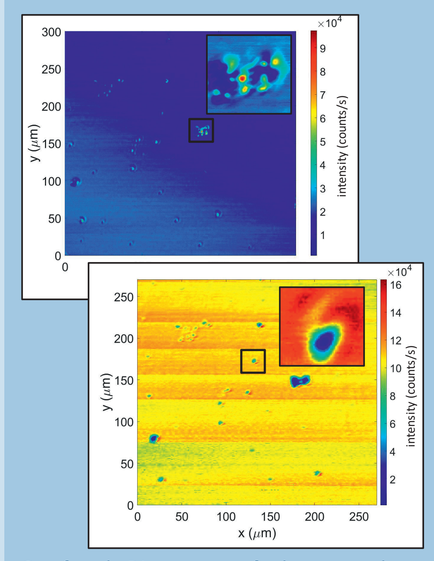


DBT powder was directly mixed with anthracene/acetone. The average crystal size was between 0.5 µm and 1 µm.

SEM images of Ac-crystals dropcasted on gold-covered glass substrates revealing the crystals' size distribution.

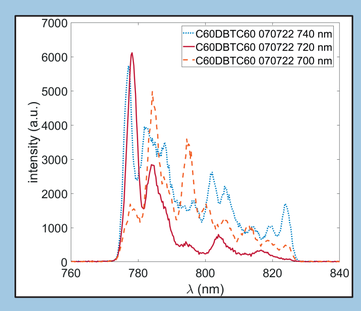
Thin Layers of DBT and C_{60}

As a first sample, DBT was evaporated for 5 minutes between several layers of the fullerene C_{60} to receive a high signal intensity for the first characterization approaches.
Scanning the DBT:C_{60} – "sandwich" sample revealed round-shaped structures accompanied by a doughnut-like spatial fluorescence intensity pattern. The area assumed to be the homogeneous DBT layers showed an almost doubled intensity compared to the doughnut patterns, as expected.



Confocal PL scans of the sample consisting of several DBT layers between a few monolayers of C_{60}. Finding the appropriate focus plane is still a challenge.

The emission spectra were recorded using a tunable white light source. By gradually lowering the excitation wavelength, potential raman signal is intended to be removed, revealing the "real" DBT:C_{60} fluorescence spectrum. Further investigations are necessary.



Emission spectrum of DBT:C_{60}. Raman signal remains even after excitation wavelength tuning. Revealing the "real" spectrum is still the main task.

OUTLOOK

We aim for a reproducible thin-layer growth technique to receive isolated single DBT molecules as single-photon emitters. For photostability, the molecules shall be incorporated either in Ac-nanocrystals or in few C_{60} monolayers. The envisioned single-photon source will be used e.g. for single-photon detector calibration.

ACKNOWLEDGEMENT

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