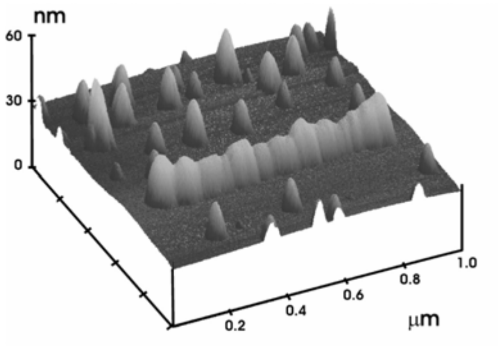
Photonics of self-assembled organic nanofibers

Motivation

Supramolecular organization at surfaces has been demonstrated to yield organic aggregates with high crystalline order and dimensions down to the nanoscale, paving the way for the realization of novel photonic and optoelectronic chips with broad applications, e.g., in information and sensor technologies.



Molecular organic nanofibers: highly crystalline needle-shaped structures self-assembled from π-conjugated molecules (oligomers) on polar surfaces like freshly cleaved muscovite mica via high-vacuum molecular deposition [1–3]. Organic nanofibers feature nanoscopic (~100 nm) cross-sectional dimensions, enabling light waveguiding [4], while ranging in length up to the millimeter scale.

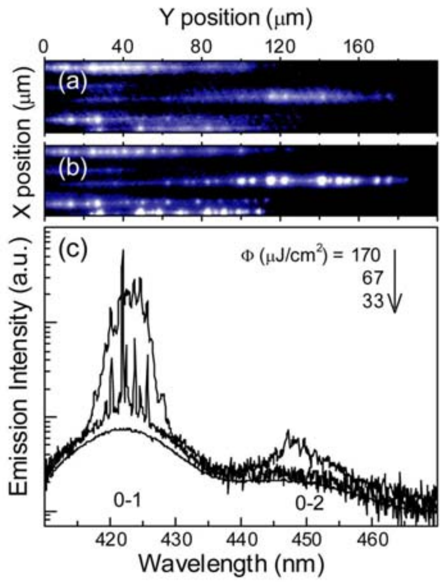
Three-dimensional topographic image of the morphology of *para*-sexiphenyl (*p*-6P) nanofibers at early stages of nucleation on muscovite mica [5]

Our contribution

- Observation of *amplified spontaneous emission* and *coherent random lasing* in *p*-6P nanofibers [5-8]
- Modelling of the photonic response of one-dimensionally disordered systems mimicking actual nanofibers
- Prospects for *nonlinear photonic sensing* devices with organic nanofibers [7,9]

Challenges

- Control over the self-assembly process
- Photonic engineering of nanofibers for practical applications



Emission micrograph of self-assembled *p*-6P nanofibers below (a) and above (b) random lasing threshold. (c) Emission spectra of a single nanofiber vs. pump fluence [8]

[1] H. Yanagi, and T. Morikawa, Appl. Phys. Lett. **75**, 187 (1999)
[2] A. Andreev, G. Matt, C.J. Brabec, H. Sitter, D. Badt, H. Seyringer, and N.S. Sariciftci, Adv. Mater. **12**, 629 (2000)
[3] F. Balzer, and H.-G. Rubahn, Appl. Phys. Lett. **79**, 3860 (2001).
[4] F. Balzer, V.G. Bordo, A.C. Simonsen, and H.-G. Rubahn, Phys. Rev. B **67**, 115408 (2003)
[5] A. Andreev, F. Quochi, F. Cordella, A. Mura, G. Bongiovanni, H. Sitter, G. Hlawacek, C. Teichert, and N. S. Sariciftci, J. Appl. Phys. **99**, 034305 (2006)
[6] F. Quochi, F. Cordella, R. Orrù, J.E. Communal, P. Verzeroli, A. Mura, G. Bongiovanni, A. Andreev, H. Sitter, and N.S. Sariciftci, Appl. Phys. Lett. **84**, 4454 (2004)
[7] F. Quochi, F. Cordella, A. Mura, G. Bongiovanni, F. Balzer, and H.-G. Rubahn, J. Phys. Chem. B **109**, 21690 (2005)
[8] F. Quochi, F. Cordella, A. Mura, G. Bongiovanni, F. Balzer, and H.-G. Rubahn, Appl. Phys. Lett. **88**, 041106 (2006)
[9] A. Rose, Z. Zhu, C. F. Madigan, T. M. Swager, V. Bulović, Nature **434**, 876 (2005)