

UNRAVELLING AND GUIDING THE FIBRE FORMATION OF A POLYPHENYLENE DENDRIMER

An Ver Heyen^α, C. C. Buron^β, K. Müllen^γ, A. Jonas^β, F. C. De Schryver^α, S. De Feyter^α

^α K.U.Leuven, Department of Chemistry, Division of Molecular and Nanomaterials, Celestijnenlaan 200F, 3001 Heverlee, Belgium; ^β Université catholique de Louvain, Unité POLY, Place Croix du Sud 1, 1348 Louvain-la-Neuve, Belgium; ^γ Max-Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany
e-mail: An.VerHeyen@chem.kuleuven.be

INTRODUCTION

Nanofabrication methods

bottom-up



SA = self-assembly
spontaneous formation of complex structures

building blocks
dendrimers, ...

top-down



guiding methods
stamps, molds,
pre-patterned
substrates, ...



fundamental
research and
functional
nanotechnologies

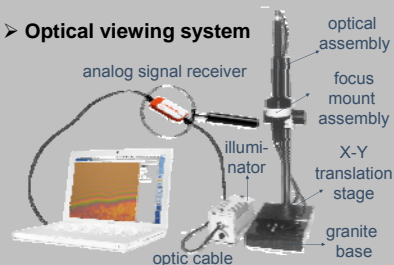
METHOD

Atomic Force Microscopy

- interaction between tip and sample
- deflection of laser beam on cantilever



Optical viewing system

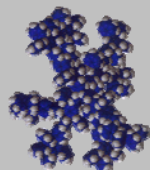


RESULTS

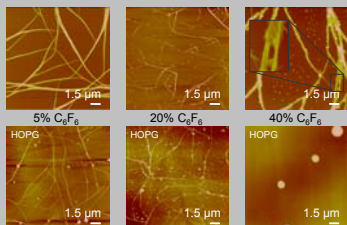
Unravelling the fibre formation

2nd generation polyphenylene dendrimer self-assembles into fibres when

- drop casting a 10^{-5} / 10^{-6} M solution (THF)
- on silicon, hogg
- in saturated environment

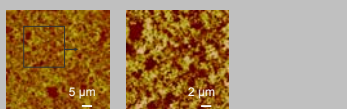


- Solvent (THF): adding increasing amount of hexafluorobenzene C₆F₆

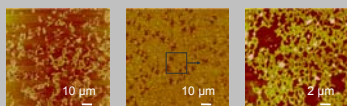


- Environment during solvent evaporation

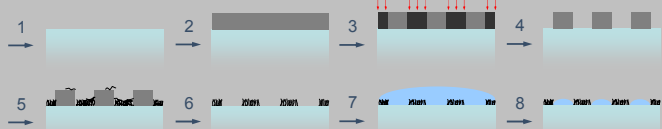
- ambient conditions



- in fridge

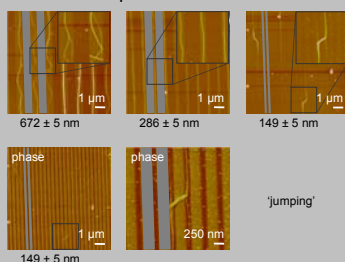


Guiding the fibre formation with binary patterns

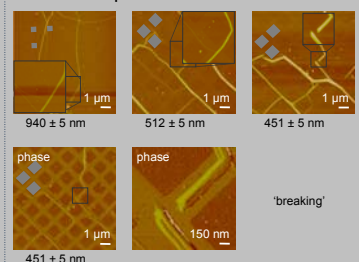


- silicon cleaning with piranha
- spin coating polymethylmethacrylate
- e-beam lithography
- development of exposed area
- grafting 1H,1H,2H,2H-perfluorodecyltrichlorosilane
- cleaning with dichloromethane
- drop casting in saturated environment
- dewetting

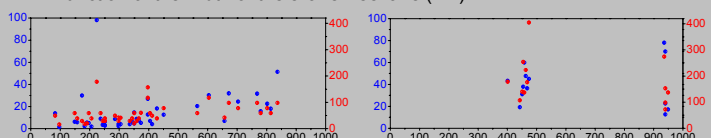
Line patterns



Block patterns



Scatter plot: height (nm) / full width at half height (FWHH, nm) of the fibres in function of the width of the silane-free lane (nm)



CONCLUSIONS & FUTURE PLANS

The second generation polyphenylene dendrimer self-assembles into fibres when drop casted from a 10^{-5} / 10^{-6} M THF-solution on several substrates in sat. env.

Substrate

- fibres formed on silicon and hogg
- no fibre formation on silicon covered with silane

Environment

during SA	solvent evaporation	interaction between dendrimers	relative positions of dendrimer-arms during sample preparation	ordering of assemblies
ambient	fast	too strong	can not be adjusted in time	low: clusters
fridge	slow	not so strong	can be adjusted	in between: network
sat. env.	slow	not so strong	can easily be adjusted	high: fibres

→ try saturated environment in fridge

Solvent

- low and intermediate concentrations of C₆F₆ added to THF blocks the fibre formation
- at high C₆F₆-concentrations added to THF: a layer of C₆F₆ is possibly formed on the hogg surface leading to fibre formation again, however with changed morphology

Guiding the fibres with binary patterns

- successful alignment
- correlation between dimension of fibres and dimension of template for line patterns
- Investigate new patterns to explain contrast issue