

## University of Groningen

### Control of pentacene thin film growth by supersonic molecular beam deposition

Wu, Yu

**IMPORTANT NOTE:** You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

*Document Version*

Publisher's PDF, also known as Version of record

*Publication date:*  
2008

[Link to publication in University of Groningen/UMCG research database](#)

*Citation for published version (APA):*

Wu, Y. (2008). *Control of pentacene thin film growth by supersonic molecular beam deposition*. s.n.

**Copyright**

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

**Take-down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

*Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.*

**RIJKSUNIVERSITEIT GRONINGEN**

# **Control of pentacene thin film growth by supersonic molecular beam deposition**

## **Proefschrift**

ter verkrijging van het doctoraat in de  
Wiskunde en Natuurwetenschappen  
aan de Rijksuniversiteit Groningen  
op gezag van de  
Rector Magnificus, dr. F. Zwarts,  
in het openbaar te verdedigen op  
vrijdag 21 november 2008  
om 14:45 uur

door

Yu Wu

geboren op 4 september 1971  
te Beijing, China

Promotor: Prof. dr. P. Rudolf

Beoordelingscommissie: Prof. dr. ir. R. Hoekstra  
Dr. S. Iannotta  
Prof. dr. T. T. M. Palstra

ISBN: 978-90-367-3574-2 (printed version)  
ISBN: 978-90-367-3579-7 (electronic version)

# Contents

<b>Chapter 1 .....</b>	<b>1</b>
1.1    Organic semiconductors in general .....	2
1.2    Overview of pentacene thin film studies .....	2
1.2.1    The pentacene molecule .....	3
1.2.2    Initial growth of a thermally sublimated pentacene thin film .....	4
1.2.3    Effects of the substrate surface on pentacene growth ..	5
1.2.4    Polymorphs of pentacene thin films .....	8
1.2.5    Defects in pentacene thin films .....	9
1.2.6    Supersonic molecular beam deposition of pentacene thin films.....	11
1.3    Purpose of the present research .....	13
1.4    Outline of the thesis.....	14
References .....	17
<b>Chapter 2 .....</b>	<b>21</b>
2.1    Supersonic molecular beam deposition .....	22
2.2    Atomic force microscopy .....	26
2.2.1    Contact mode atomic force microscopy.....	28
2.2.2    Tapping mode atomic force microscopy .....	31
2.3    Contact angle measurement.....	34

References .....	35
------------------	----

## **Chapter 3 .....37**

3.1 Introduction .....	38
3.2 Pentacene submonolayer growth on SiO <sub>x</sub> by supersonic molecular beam deposition.....	39
3.2.1 SiO <sub>x</sub> substrate preparation .....	39
3.2.2 Characterization of the supersonic molecular beam by time of flight mass spectroscopy .....	40
3.2.3 Growth of pentacene submonolayers on SiO <sub>x</sub> .....	42
3.3 Investigation of pentacene submonolayer growth.....	44
3.3.1 Formation of pentacene islands.....	44
3.3.2 Morphological evolution of the pentacene submonolayer .....	54
3.3.3 Crystallinity of first pentacene monolayer .....	56
3.4 Conclusions .....	58
References .....	59

## **Chapter 4 .....63**

4.1 Introduction .....	64
4.2 Experiments.....	65
4.3 Investigation of pentacene submonolayer growth with different E <sub>k</sub> and θ at RT.....	66
4.3.1 Evolution of pentacene submonolayer morphology...	66

4.3.2	Investigation of pentacene island size and critical nucleus size.....	73
4.4	Pentacene submonolayer growth with different $E_k$ and $\theta$ at 200K .....	77
4.5	Conclusions .....	81
	References.....	82
	<b>Chapter 5 .....</b>	<b>85</b>
5.1	Introduction .....	86
5.2	Experiments.....	88
5.3	Investigation of the morphology of pentacene films grown on a $\text{SiO}_x$ surface patterned with Au electrodes .....	89
5.4	Electrical characterization of pentacene ultrathin film based field effect transistors .....	97
5.5	Conclusions .....	102
	References .....	103
	<b>Summary .....</b>	<b>107</b>
	<b>Samenvatting.....</b>	<b>111</b>
	<b>Acknowledgements .....</b>	<b>115</b>
	<b>List of Publications .....</b>	<b>119</b>

