

University of Groningen

Fullerenes for organic electronics

Kooistra, Floris Berend

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:

2007

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

Citation for published version (APA):

Kooistra, F. B. (2007). Fullerenes for organic electronics [Groningen]: 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).

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.

Fullerenes for Organic Electronics

Floris Berend Kooistra

PhD thesis Groningen University

ISBN: 978-90-367-3256-7 (printed version)

ISBN: 978-90-367-3257-4 (electronic version)

© Floris Berend Kooistra, Groningen, **2007**

Printed by: PrintPartners Ipskamp B.V., Enschede, The Netherlands.

Cover design: Floris Kooistra and Frank Brouwer

Cover picture: Michael Coleman (www.flickr.com)



**rijksuniversiteit
 groningen**



The work carried out in this thesis was performed within the Stratingh Institute of Chemistry of the University of Groningen

Part of the work described in this thesis was financially supported by the European Space Agency under project number: AO 99-121



University of Groningen
**Zernike Institute
 for Advanced Materials**

Part of the work described in this thesis was financially supported by the Zernike Institute for Advanced Materials.

**Zernike Institute PhD thesis
 series 2007-17**

ISSN: 1570-1530

RIJKSUNIVERSITEIT GRONINGEN

Fullerenes for Organic Electronics

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 30 november 2007
om 13.15 uur

door

Floris Berend Kooistra

geboren op 28 april 1979
te Amersfoort

Promotor: Prof. dr. J.C. Hummelen

Beoordelingscommissie: Prof. dr. P.W.M. Blom
Prof. dr. K. Meerholz
Prof. dr. N. Martín León

ISBN: 978-90-367-3257-4 (electronic version)

ISBN: 978-90-367-3256-7 (printed version)

Contents

Chapter 1	Introduction	5
1.1	Fullerenes	6
1.2	PCBM	7
1.3	Fullerenes in Organic Electronics	8
1.4	Outline and Aim of this Thesis	21
1.5	List of Publications	22
1.6	References	23
Chapter 2	[84]PCBM and its Application in a Bulk Heterojunction Solar Cell	31
2.1	Introduction	32
2.2	Synthesis	36
2.3	Characterization	36
2.4	Photovoltaic Devices	41
2.5	Discussion	45
2.6	Conclusions	47
2.7	Experimental	48
2.8	References	50
Chapter 3	Increasing the V_{oc} of Bulk Heterojunction Solar Cells by raising the LUMO level of the Acceptor	53
3.1	Introduction	54
3.2	Synthesis	57
3.3	Characterization	60
3.4	Solar Cell Devices	64
3.5	Conclusions	65
3.6	Experimental	66
3.7	References	82

Chapter 4	Air Stable Organic Field Effect Transistors	85
4.1	Introduction	86
4.2	Synthesis	90
4.3	[84]PCBM Organic Field Effect Transistors	94
4.4	Field Effect Transistors of fluorine containing fullerene derivatives	101
4.5	Conclusions	106
4.6	Experimental	106
4.7	References	116
Chapter 5	Fullerenes for Time-Gated Holographic Imaging	119
5.1	Introduction	120
5.2	Fullerene Sensitizers for TGHI	125
5.3	Low T_g Fullerenes for inverted photorefractive materials	131
5.4	Conclusions	136
5.5	Experimental	136
5.6	References	154
Chapter 6	π-Conjugated Fullerene Adducts	157
6.1	Introduction	158
6.2	Synthesis	164
6.3	[6,6]Bridged Fullerenes	168
6.4	[5,6]Bridged Fulleroids	174
6.5	Conclusions	177
6.6	Experimental	178
6.7	References	181
Chapter 7	Giant Pearl-Necklace Fullerene Macrocycles	185
7.1	Introduction	186
7.2	Synthesis	191

Contents

7.3	MALDI-TOF Spectroscopy	193
7.4	Conclusions	197
7.5	Experimental	197
7.6	References	200
Appendix I	MALDI-TOF Spectra Chapter 7	203
Samenvatting		213
Summary		219
Dankwoord		225

