Glow with the flow: Quantifying blood flow and photoluminescence signal in biological tissue
Nadort, A.

Citation for published version (APA):
Glow With The Flow.
A thesis that contributes to the development of optical techniques to assess microcirculation functionality for the diagnosis, monitoring, therapy guidance and understanding of many diseases ranging from the onset of septic shock to the delivery of drugs to tumours. The first part of this thesis aims to develop a non-invasive technique to quantify microcirculatory blood flow velocity based on laser speckle flowmetry. The second part is devoted to the quantification of optical signals arising from photoluminescent upconversion nanoparticles for sensitive detection in biomedical tissues. The combination of these techniques is particularly useful in the context of tumour therapy by providing information on tumour angiogenesis, enabling molecular contrast and delivering nanoparticle-based drugs.
GLOW WITH THE FLOW: QUANTIFYING BLOOD FLOW AND PHOTOLUMINESCENCE SIGNAL IN BIOLOGICAL TISSUE

Annemarie Nadort
Glow with the flow: Quantifying blood flow and photoluminescence signal in biological tissue
PhD thesis, University of Amsterdam, The Netherlands

The research in this thesis was funded by:

The public defence ceremony and printing of this thesis were kindly sponsored by:

Author: Annemarie Nadort
Printing: Off-page, www.offpage.nl
Cover design: CAPITAL T
Tim Casey, CapitalT.net

Copyright 2015 © Annemarie Nadort, Amsterdam, The Netherlands. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the copyright owner.
Glow with the flow: Quantifying blood flow and photoluminescence signal in biological tissue

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. dr. D.C. van den Boom
ten overstaan van een door het College voor Promoties ingestelde
commissie, in het openbaar te verdedigen in de Agnietenkapel
op woensdag 1 april 2015, te 14:00 uur

door

Annemarie Nadort

geboren te Zaanstad
PROMOTIECOMMISSIE

Promotores: prof. dr. A.G.J.M. van Leeuwen Universiteit van Amsterdam
             prof. dr. M.C.G. Aalders Universiteit van Amsterdam

Co-promotor: dr. ir. D.J. Faber Universiteit van Amsterdam

Overige leden: prof. dr. E.T. van Bavel Universiteit van Amsterdam
               prof. dr. W.J. Buma Universiteit van Amsterdam
               prof. dr. H.J.C.M. Sterenborg Erasmus Universiteit Rotterdam
               prof. dr. ir. W. Steenbergen Universiteit Twente
               dr. E.G. Mik Erasmus MC

Faculteit der Geneeskunde
# Table of Contents

Chapter 1  Introduction 7

Chapter 2  Laser speckle contrast imaging 25

Chapter 3  Quantitative laser speckle flowmetry of the *in vivo* microcirculation using sidestream dark field microscopy 37

Chapter 4  Quantitative blood flow velocity imaging using laser speckle flowmetry 57

Chapter 5  Upconversion nanoparticles 91

Chapter 6  Quantitative imaging of single upconversion nanoparticles in biological tissue 103

Chapter 7  Feasibility study of the optical imaging of a breast cancer lesion labeled with upconversion nanoparticle biocomplexes 133

Chapter 8  Discussion and conclusion 155

Chapter 9  Outlook 173

Appendices  List of abbreviations 181
          List of symbols 182
          Samenvatting van het proefschrift 185
          Thesis summary 191
          List of publications 197
          Portfolio 200
          Curriculum vitae 203
          Acknowledgments 205