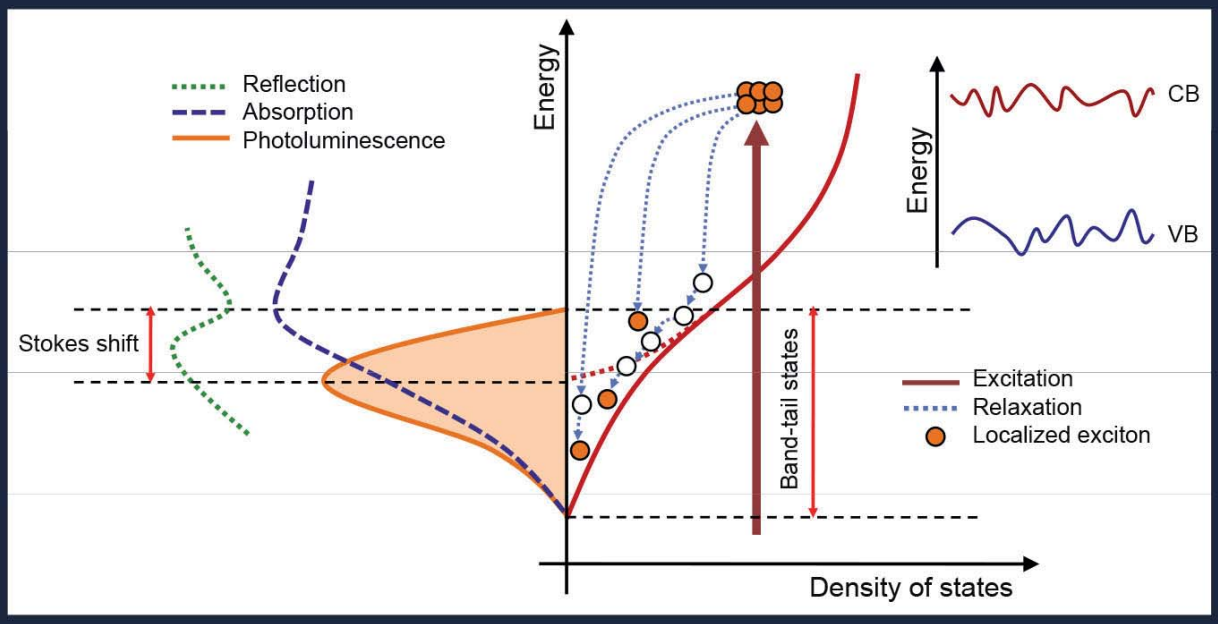
Mohammad Khaled Shakfa

Localization Effects in Disordered III-V Semiconductor Nanostructures



Cuvillier Verlag Göttingen
Internationaler wissenschaftlicher Fachverlag

Localization Effects in Disordered III-V Semiconductor Nanostructures

Localization Effects in Disordered III-V Semiconductor Nanostructures

Der Fakultät für Elektrotechnik, Informationstechnik, Physik
der Technischen Universität Carolo-Wilhelmina zu Braunschweig

zur Erlangung des Grades eines Doktors

der Ingenieurwissenschaften (Dr.-Ing.)

genehmigte Dissertation

von Dipl.-Phys. Mohammad Khaled Shakfa
aus Homs, Syrien

eingereicht am:	22.06.2015
mündliche Prüfung am:	29.07.2015
1. Referent:	Prof. Dr. rer. nat. Martin Koch
2. Referent:	Prof. Dr. rer. nat. Tobias Voss

2015

Bibliografische Information der Deutschen Nationalbibliothek

Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliographie; detaillierte bibliografische Daten sind im Internet über http://dnb.d-nb.de abrufbar.

1. Aufl. - Göttingen: Cuvillier, 2015
Zugl.: (TU) Braunschweig, Univ., Diss., 2015

Dissertation an der Technischen Universität Braunschweig,
Fakultät für Elektrotechnik, Informationstechnik, Physik

Nonnenstieg 8, 37075 Göttingen
Telefon: 0551-54724-0
Telefax: 0551-54724-21
www.cuvillier.de

1. Auflage, 2015
Gedruckt auf umweltfreundlichem, säurefreiem Papier aus nachhaltiger Forstwirtschaft.

ISBN 978-3-7369-9160-6
eISBN 978-3-7369-8160-7

To my family

Making a mistake is not a big deal as long as you have learned from ...

Acknowledgements

During my years as a PhD-student at the *Braunschweig University of Technology* and then at the *Philipps University of Marburg* I have had the pleasure of meeting and working with many great people who contributed to this work in various ways. It would be impossible to properly express my full gratitude and heartfelt thanks to all of them for their help and support in just a few lines. Nevertheless, I will try to make an attempt.

First and foremost, I would like to express my sincere gratitude to my doctoral father, Prof. Dr. Martin Koch for having given me the great opportunity to learn and work in his group. My deepest appreciation goes to him for giving me the freedom to pursue the research that seemed interesting to me. He gave me the opportunity to work on several different experiments. His broad and deep knowledge combined with his insights and criticisms were valuable as well as invaluable at times. I have enormously benefited from our many discussions on various topics and from the nice environment he has created with his good humour and energy. I am grateful to him for all kinds of support he has given me. He has always been ready to offer his help whenever needed, to discuss solutions to the many roadblocks I encountered on the way, and to solve seemingly insurmountable problems. Without his consistent encouragement, trust, guidance, and mentorship, it would have been impossible for me to complete this thesis.
Prof. Koch, I have learnt a lot of things from you which I will carry with me as I move forward, not only in the academic aspect, thank you for a fantastic PhD experience!

I extend my appreciation to the members of the thesis defense committee, Prof. Dr. Tobias Voss and Prof. Dr. Andreas Waag from the the *Braunschweig University of Technology* for their genuine interest in my research topic, for the time and effort they put into reading this work, and for generously offering me valuable feedback and recommendations to improve my thesis.

Beside my supervisor, it has been a great privilege and pleasure for me to work with Prof. Dr. Sergei Baranovski, Dr. Kakhaber Jandieri, and Martin Wiemer. Their profound knowledge and insightful thoughts in disordered semiconductor physics have been a crucial resource that I have enormously benefited in my studies. Without their unflagging mentorship and the invaluable discussions I had with them, it would have been impossible for me to do this thesis. At this point, I am very grateful to Martin Wiemer for his wise advice and very constructive and useful comments regarding the text of my thesis.

I would like to equally thank Prof. Dr. Kerstin Volz; Dr. habil. Wolfgang Stolz; and Priv. Doz. Dr. Sangam Chatterjee from the *Philipps University of Marburg*, Prof. Dr. Dan A. Beaton from the *University of British Columbia*, and Prof. Dr. Thomas Tiedje from the *University of Victoria*, for providing me semiconductor structures. I would like to thank the *German Science Foundation* (DFG) through the Research Training Group (GRK 1782) and MARA - *MArburg University Research Academy* through the DAAD STIBET Program for the financial support.

I am indebted to Alexej Chernikov who introduced to me the experimental setup and was always open for discussions. I would like to thank Marina Gerhard and Ronja Woscholski for sharing their experimental skill and experience, and for many useful scientific discussions. During my PhD, I had the honor to supervise two students; Dimitri Kalincev for his diploma thesis and Tashneem Ara Islam for her master thesis, thank you both for your great work. Many thanks goes to our VECSEL team; Christoph Möller, Mahmoud Gaafar, Fan Zhang, and Arash Rahimi Iman for the very fruitful collaboration. Thanks in particular to Matthias Wichmann for the great time together.

A big thanks goes out to Ibraheem Al-Naib and Mohammed Salhi for their genuine support, tips and advices in my early time in Braunschweig and for their sincere friendship, or rather brothership, over the years. I would like to offer my sincerest gratitude to Nico Vieweg for being a good friend and perfect colleague. I am deeply indebted to him for his help, support, and the great time together in the laboratory. It has been an absolute pleasure working with him. The time I spend with Nico has been quite memorable.

My thanks are due to other current and past colleagues and PhD-students in our research group including, Amin Soltani, Thorsten Probst, Sina Lippert, Claudia Goy, Norman Born, Stefan Sommer, Oday Abdulmunem, Muhaned Bilal, Christian Jansen, Christian Jördens, Benedikt Scherger, Ole Peters, and Matthias Stecher, to name a few, for the friendly working environment and ever helping attitude.

With all my respect, I am very grateful to my family and would like to especially thank my parents for everything they have done for me to overcome all of the difficulties throughout my life and for their constant guidance and encouragement to reach this advanced education that they have missed in their own lives. My siblings; Hala, Khozama, and Mohammad, you have always been an inspiration to me. My little son, Hassan, no words can express my happiness when I see your smiley innocent face. You have made my life busy but enjoyable and worthwhile. Last but certainly not least, I reserve my deepest gratitude to my beloved wife, Dalia for her sacrifice, patience, unconditional support, and always believing in me.

Marburg, in June 2015 M. Khaled Shakfa

Contents