University of Groningen

Multi-functional diamond particles for various applications

Tian, Yuchen

DOI:
[10.33612/diss.198170468](https://doi.org/10.33612/diss.198170468)

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:
2022

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

Citation for published version (APA):
Tian, Y. (2022). *Multi-functional diamond particles for various applications*. [Thesis fully internal (DIV), University of Groningen]. University of Groningen. <https://doi.org/10.33612/diss.198170468>

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.

Multi-functional diamond particles for various applications

Yuchen Tian

Multi-functional diamond particles for various applications

Copyright©2022 **Yuchen Tian**

Cover designed by: **Zidan Li**

Printed by: **Gildeprint, Enschede**

ISB: **978-94-6419-422-7**

Multi-functional diamond particles for various applications

university of
groningen

Multi-functional diamond particles for various applications

PhD thesis

to obtain the degree of PhD at the
University of Groningen
on the authority of the
Rector Magnificus Prof. C. Wijmenga
and in accordance with
the decision by the College of Deans.

This thesis will be defended in public on
Wednesday 2 February 2022 at 11.00 hours

by

Yuchen Tian

born on 26 November 1990
in Anhui, China

Supervisor

Prof. R. Schirhagl

Co-supervisor

Prof. S.K. Padamati

Assessment Committee

Prof. W.R. Browne

Prof. Wu

Prof. Lieberzeit

To my family

Paranimfen

Ke Ren

Runrun Li

CONTENTS

Chapter I	General Introduction	
1.1	Scientifically relevant Diamond properties	3
1.2	The Nitrogen-Vacancy (NV) center	4
1.3	Biological application research with FNDs	5
1.4	Bulk diamond applications	6
1.5	Outline of this thesis	7
1.6	References	8
Chapter II	Functionalized Fluorescent Nano Diamonds for simultaneous drug delivery and quantum-sensing in HeLa cells	
2.1	Introduction	15
2.2	Materials and Methods	16
2.3	Results and Discussion	22
2.4	Conclusions	28
2.5	References	29
Chapter III	Using a gradient approach for systematic optimization of diamond surfaces	
3.1	Introduction	35
3.2	Materials and Methods	37
3.3	Results and Discussion	40
3.4	Conclusions	46
3.5	References	47
Chapter IV	Differentiating Rheumatoid Arthritis and Osteoarthritis by nanoscale magnetometry	
4.1	Introduction	55
4.2	Materials and Methods	57
4.3	Experiment Sections	57
4.4	Results and Discussion	59
4.5	Conclusions	63
4.6	References	64
Chapter V	Discussion	
5.1	Free radical detection	71
5.2	Chemical Gradients on Diamond Surfaces	72
5.3	Outlook to the future	73
5.4	References	74

Contents

Summary	77
Samenvatting	79