University of Groningen

Controlling the activity of antibiotics by ultrasound

Zou, Miancheng

DOI:
[10.33612/diss.200121309](https://doi.org/10.33612/diss.200121309)

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):
Zou, M. (2022). *Controlling the activity of antibiotics by ultrasound*. [Thesis fully internal (DIV), University of Groningen]. University of Groningen. <https://doi.org/10.33612/diss.200121309>

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.

Controlling the activity of antibiotics by ultrasound

Miancheng Zou

Controlling the activity of antibiotics by ultrasound

Miancheng Zou

PhD thesis

University of Groningen

Zernike Institute PhD thesis series 2022-03

ISSN 1570-1530

The research described in this thesis was performed in Polymer Chemistry and Bioengineering Group at Zernike Institute for Advanced Materials, University of Groningen, the Netherlands. This work was financially supported from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie (No. 713482) and European Research Council Advanced Grant SUPRABIOTICS (No. 694610).

Cover design: Miancheng Zou

Printed by: Ipskamp

**university of
 groningen**

**faculty of science
 and engineering**

**zernike institute for
 advanced materials**

university of
groningen

Controlling the activity of antibiotics by ultrasound

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

Tuesday 15 February 2022 at 12.45 hours

by

Miancheng Zou

born on 15 April 1991
in Henan, China

Supervisor

Prof. A. Herrmann

Co-supervisor

Prof. G. Portale

Assessment Committee

Prof. H. Boerner

Prof. A.J. Minnaard

Prof. A.S.S. Dömling

Dedicated to my beloved family

Contents

Chapter 1	9
Stimuli-Responsive Nano/Micro-Architecture Drug-Delivery Systems: Past, Present, and Future Perspectives	9
Abstract	10
1.1 Introduction	11
1.2. Stimuli-responsive drug delivery systems	13
1.2.1. Endogenous stimuli-responsive drug delivery system	14
1.2.1.1 pH-responsive drug delivery system	14
1.2.1.2 Redox-responsive drug delivery system	16
1.2.1.3 Enzyme-responsive drug delivery	18
1.2.2. Exogenous stimuli-responsive DDSs	20
1.2.2.1 Magnetic-responsive drug delivery	20
1.2.2.2 Photo-responsive drug delivery	22
1.2.2.3 Ultrasound-responsive drug delivery	24
1.3. Mechanochemistry	25
1.3.1 Mechanism	26
1.3.2 Transformations	26
1.4 Conclusions	29
1.5 Motivation and thesis outline	30
References	33
Chapter 2	38
Activation of Antibiotic-Grafted Polymer by Ultrasound	38
Abstract	39
2.1 Introduction	40
2.2 Results and discussion	41
2.3 Conclusions	43
2.4 Experimental sections.	43
2.5 Supporting figures and tables	53
References	55
Chapter 3	57

Activation of Drugs from Van-DADA Nanoparticle Assemblies.....	57
Abstract.....	58
3.1 Introduction.....	59
3.2 Results and discussion	60
3.3 Conclusions.....	63
3.4 Experimental sections	63
3.5 Supporting figures and tables.....	69
References.....	73
Chapter 4.....	74
Activation of Antibiotic-Grafted Polymer Brushes by Ultrasound.....	74
Abstract.....	75
4.1 Introduction.....	76
4.2 Results and discussion	77
4.3 Conclusions.....	79
4.4 Experimental sections	80
4.5 Supporting figures and tables.....	87
References.....	94
Chapter 5.....	96
Microgels as drug carriers for sonopharmacology.....	96
Abstract.....	97
5.1 Introduction.....	98
5.2 Results and discussion	99
5.3 Conclusions.....	104
5.4 Experimental sections	104
5.5 Supporting figures and tables.....	107
References.....	130
Summary	132
Samenvatting.....	136