

I. IDENTIFICATION DATA

Thesis name:	Development of microbial resistance in response to non-lethal nanoparticle exposure: S. aureus study.
Author's name:	Eva Wohlgemuthova
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Circuit Theory
Thesis supervisor:	David Rutherford
Supervisor's department:	Physics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	challenging
<i>Evaluation of thesis difficulty of assignment.</i>	
<p>The most challenging aspect of this research project was the amount of laboratory work that was involved. Experiments had to be done on 3 consecutive days each week, for a number of consecutive weeks. The workload, whilst quite extensive for a Bachelor thesis, was necessary in order to investigate the potential development of resistance by bacteria when re-exposed to non-lethal concentrations of antibacterial nanoparticles. The aim of the experiment was to expose non-pathogenic bacteria to non-lethal concentrations of zinc oxide nanoparticles, recover the surviving bacteria, and then re-expose the bacteria to the same treatment. Bacteria not exposed to nanoparticles acted as a reference control, and the difference between the reference bacteria and bacteria exposed to nanoparticles was the method used to assess resistance development. This process of re-exposing surviving bacteria continued for 9 weeks (first week using stock bacteria and 8 re-exposures). Experimental work involving bacteria is always difficult and perfect aseptic technique is critical to prevent contamination which would invalidate the results.</p>	

Satisfaction of assignment	fulfilled
<i>Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.</i>	
<p>The submitted thesis successfully investigated the potential development of resistance by bacteria towards exposure to non-lethal concentrations of antibacterial nanoparticles. Multiple re-exposures were carried out over 9 consecutive weeks during the semester, however there was no evidence of resistance development under these controlled conditions. The fact that there was no evidence of resistance development is a positive outcome with regards to nanoparticle use for antibacterial treatments. However, one possible shortcoming might be that the concentration of antibacterial nanoparticles used was too low to induce enough stress that would be needed to cause the development of resistance.</p>	

Activity and independence when creating final thesis	A - excellent.
<i>Assess that student had positive approach, time limits were met, conception was regularly consulted and was well prepared for consultations. Assess student's ability to work independently.</i>	
<p>The student was always punctual for the scheduled laboratory work and was very enthusiastic about the research. They learnt the techniques needed for the experiments very quickly and displayed a high level of competence throughout the experiments. After only a few weeks, the student was able to work unsupervised in the laboratory which shows a high level of independence. Also, it was clear early in the semester that they understood the concept of the research and there were regular consultations after each week's experiments to discuss the results.</p>	

Technical level

B - very good.

Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.

I think that the level of thesis specialty is high and addresses an important concept which is currently very relevant. Antimicrobial resistance is well known but what is less well understood is the potential development of resistance towards zinc oxide nanoparticles when used as an antimicrobial treatment. To date, there is only one peer-reviewed research article that has investigated bacterial resistance development towards nanoparticle re-exposure, using silver instead of zinc oxide. To the best of my knowledge, this is the first research investigating the development of resistance towards zinc oxide nanoparticles. After 8 re-exposures to a low concentration of zinc oxide nanoparticles, there was no evidence of the development of resistance which is an important finding for technologies that use nanoparticles to kill bacteria.

Formal and language level, scope of thesis

B - very good.

Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.

I think the level of English language in the thesis is very good, especially considering the specialist vocabulary required and the nature of the research. The thesis was well structured and arranged in a logical manner. Relevant information was contained in the background information and the experimental section was detailed so that the experiment could be easily reproduced. Graphical representations of the results were presented clearly and labelled correctly.

Selection of sources, citation correctness

A - excellent.

Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.

Once the student understood the concept of the project and the general theme, they were able to find their own relevant material to create this thesis. The references covered all the necessary background information using a range of sources, from research articles to public health guidance. Any material referenced in the thesis is clearly distinguishable from the students own thoughts or reasoning, and the references are clearly visible in the text at the correct position in the text. Any images or figures that are not the student's own creation are also correctly referenced.

Additional commentary and evaluation

Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.

I believe the results of this thesis merits publication and I submit the work as a conference proceedings manuscript to NANOCON, due to be held later this year in Brno.

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Summarize thesis aspects that swayed your final evaluation.

The quality of the laboratory work was very high and consistent throughout the project which deserves recognition. To maintain this high standard week after week is difficult but the student managed it with ease. The student quickly learnt experimental techniques and worked independently after some initial training. The thesis itself is a comprehensive report with an extensively detailed experimental section, which is an important aspect of experimental research to ensure reproducibility and it is often overlooked. The student found that bacteria did not develop resistance to antibacterial nanoparticle re-exposure, which is an important finding considering resistance to conventional antimicrobials is increasing.

I evaluate handed thesis with classification grade **A - excellent**.

Date: **11.1.2022**

Signature: