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KNOW YOUR ENEMY

Characterizing Pathogenic Biomaterials Using Laser Tweezers

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Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet för avläggande av filosofie doktorsexamen framläggs till offentligt försvar i NAT.D.410, Naturvetarhuset, fredagen den 11 Mars, kl. 09:00.

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Abstract
Diseases caused by pathogenic agents such as bacteria and viruses result in devastating costs on personal and societal levels. However, it is not just the emergence of new diseases that is problematic. Antibiotic resistance among bacteria makes uncomplicated infections difficult and lethal. Resilient disease-causing spores spread in hospitals, the food industry, and water supplies requiring effective detection and disinfection methods. Further, we face complex neurological diseases where no effective treatment or diagnostic methods exist. Thus, we must increase our fundamental understanding of these diseases to develop effective diagnostic, detection, disinfection, and treatment methods.

Classically, the methods used for detecting and studying the underlying mechanics of pathogenic agents work on a large scale, measuring the average macroscopic behavior and properties of these pathogens. However, just as with humans, the average behavior is not always representative of individual behavior. Therefore, it is also essential to investigate the characteristics of these pathogens on a single cell or particle level.

This thesis develops and applies optical techniques to characterize pathogenic biomaterial on a single cell or particle level. At the heart of all these studies is our Optical Tweezers (OT) instrument. OT are a tool that allows us to reach into the microscopic world and interact with it. Finally, by combining OT with other experimental techniques, we can chemically characterize biomaterials and develop assays that mimic different biological settings. Using these tools, we investigate bacterial adhesion, disinfection, and detection of pathogenic spores and proteins.
Hopefully, the insights of these studies can lessen the burden on society caused by diseases by helping others develop effective treatment, diagnostic, detection, and disinfection methods in the future.

Keywords
Optical Tweezers, Laser Tweezers, Bacterial Adhesion, Microfluidics, 3D Printing, Biophysics, Multidisciplinary Research, Bacterial spores, Cryptosporidium, Raman Spectroscopy

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