Functionalized organic coatings as bioelectronic interfaces

Abstract

The advancement of implantable bioelectronic devices holds significant promise for applications in neural engineering, biosensing, and electroceutical therapies. However, the long-term performance and integration of these devices are critically dependent on several characteristics, such as electrochemical properties, biocompatibility, and functional adaptability of the electrode-tissue interface. The aim of this thesis was to develop and investigate advanced surface functionalization strategies to enhance these key characteristics, with a key focus on electrochemical modification methods, incorporating conducting polymers, deposition of metal particles, and electrografting of diazonium salts. These methods were further complemented by secondary surface treatments, including physical approaches such as solvent treatment, and chemical strategies like covalent coupling. All proposed functionalization methods were followed by comprehensive characterization of relevant parameters, such as morphology, electrical and electrochemical performance, biocompatibility, and antibacterial properties.

The research presented in this thesis contributes to the growing library of surface functionalization strategies for bioelectronic devices. By offering tailored solutions to meet diverse functional requirements, these approaches support the development of more efficient and adaptable material interfaces. Given the rapid growth of the bioelectronics market and its increasing demand for high-performance, biocompatible, and multifunctional materials, such advancements are particularly valuable for accelerating innovation in next-generation implantable bioelectronic devices.