# ABSTRACT


Electroactive polymers (EAPs) based actuators have received much attention in the past few decades. The ionic polymer metal composites (IPMCs) are an important class of electroactive polymers (EAPs) that are gaining popularity due to their benefits of bidirectional large bending deformation, low power consumption, lightweight, and biocompatibility. IPMC-based smart materials can function as actuators or sensors in robotics, industrial, and biomedical applications. Catheterization-based minimally invasive surgeries (MIS) have grown significantly in the field of medical science. Physicians can now perform complex surgeries more easily without provoking discomfort to the patient. Many different types of catheters have been manufactured and utilized to treat various ailments such as congenital heart defects, neurovascular surgery, gastro-urinary tract infections, thrombosis burden, arterial spasms, aneurysms, and so on. However, the precise positioning and maneuverability of the catheter-guidewire tip within the blood vessels remain challenging for clinicians due to intricate anatomy. The operator's skills influence the steerability of the catheter or guidewire tip; this lengthens the procedure and radiation exposure time for the operator and the patient. During this time, a blood vessel may become completely clogged, causing unintended harm to a non-diseased area and tissues. Continuous attempts have been made to address these issues. Many prototypes have been developed to add functionality and fidelity to improve catheter-guidewire steerability. Despite the availability of cutting-edge technologies, intravascular navigation with critical angulation poses a challenge to physicians. In this dissertation, COMSOL Multiphysics software is used to perform finite element modelling (FEM) of the IPMC actuator prior to real-time development. A cost-effective physical vapor deposition (PVD) and electroless deposition techniques are used to fabricate an EAP-based IPMC actuator successfully. The actuation performance of gold and platinum electrodes-based IPMC is investigated in different environmental conditions such as air, deionized water and blood analogue fluid. For motion analysis of the IPMC actuator, a cost-effective open-source software-based alternative has been provided. A smartphone-based Bluetooth-controlled setup for IPMC actuation testing has been developed to circumvent the limitations of traditional wired and battery-powered complex electronic circuits. Two types of active catheter-guidewire prototypes have been built and successfully demonstrated the proof-of-concept for biomedical applications.



**Keywords:** *Smart materials, electroactive polymer (EAP), ionic polymer-metal composite (IPMC), actuator, minimally invasive surgery (MIS), steerable catheter, active catheter and guidewire.*