Title: Engineering of Triboelectric-Nanogenerator (TENG) Powered Devices and Lab-on-a-Chip Devices for Biological Applications

The triboelectric effect is the phenomenon that when two different materials come into contact through friction, their surfaces become oppositely charged. Triboelectric-nanogenerator (TENG) was invented based on this phenomenon to effectively harness ambient mechanical energy that is omnipresent but usually not effectively utilized in daily life. Lab-on-a-chip (LOC) technology is usually referred as a device that integrates one or several laboratory functions on a single chip, with features such as low fluid volumes consumption, faster analysis and response times and better process control. In this thesis, TENG powered devices and LOC Devices are engineered to realize various biomedical applications. First, a rotary TENG was utilized to harvest energy from human body's motion to power an implantable drug delivery actuator for controlled and localized administration of drugs. In another application as energy source, the same TENG was used for photodynamic therapy to demonstrate an enhanced therapeutic effects of a chemo drug when being applied together with a photosensitizer, chlorin e6. Other than being used as energy source, the output of TENG can also be utilized directly as electrical stimulations. A contact-separation mode TENG was used in a nanowires-assisted electroporation system to generate electrical stimulations which induce perforation on cancer cells, thus facilitating the transfection of siRNA without the aid of nano-carriers. This system can serve as an effective and versatile platform for high-throughput gene delivery in biological research and cancer treatment studies. In the realm of LOC devices, a biochip was developed for dual functions of preserving the viability of epithelial tissues as well as real time monitoring the transepithelial resistance of the tissue on-chip. Last, the strengths of TENG and LOC were effectively utilized to develop a fundamentally new method for detecting trace amount of heavy metals in water. By coating the sensing surface with specific chelating agent, selective detection of lead ions was achieved.