

# **Flexible Nanogenerators for Self-Powered Wearable and Implantable Electrostimulation Devices**

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Today, the emergence of wearable devices is rapidly reshaping the development of medical devices, pushing them from conventional bulky and rigid silicon electronics to flexible and primarily polymer-based systems. Among many types of functions, nanogenerators are developed as a unique device for converting biomechanical energy into electrical pulses. This talk will first introduce the principles and materials development of flexible nanogenerators as an implantable power source. In addition to the electric output investigation, mechanical property tuning and biosafety and compatibility are particularly important for biomedical applications. In addition to be used as an electrical energy source, the pulsed electricity from nanogenerators can be applied directly as an electrostimulation (ES) signal for therapeutic treatment. In our recent research, we successfully implemented such an electromechanical system for skin wound healing, hair growth, and vagus nerve stimulation for obesity control. An electrical stimulation bandage was developed by integrating a flexible nanogenerator and a pair of dressing electrodes on a flexible substrate. Rat studies demonstrated rapid closure of a full-thickness rectangular skin wound within 3 days as compared to 12 days of usual contraction-based healing processes in rodents. Via a similar design, the electrical pulses were applied to stimulate hair growth. Significantly facilitated hair regeneration results were obtained from Sprague-Dawley rats and nude mice. In another work, an implanted vagus nerve stimulation system was developed. It generates biphasic electric pulses in responsive to the peristalsis of stomach. The electric signals generated by this device stimulates the vagal afferent fibers to reduce food intake and achieve weight control. All the results bring a new concept in electrical therapeutic technology that is battery-free, self-activated and directly responsive to body activities.