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An Etching Free Facile Method for Scalable Fabrication of Freestanding Metallic Micro-and Nano-tubes with Controllable Twisting

Manufacturing

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Nanotechnology and New Materials

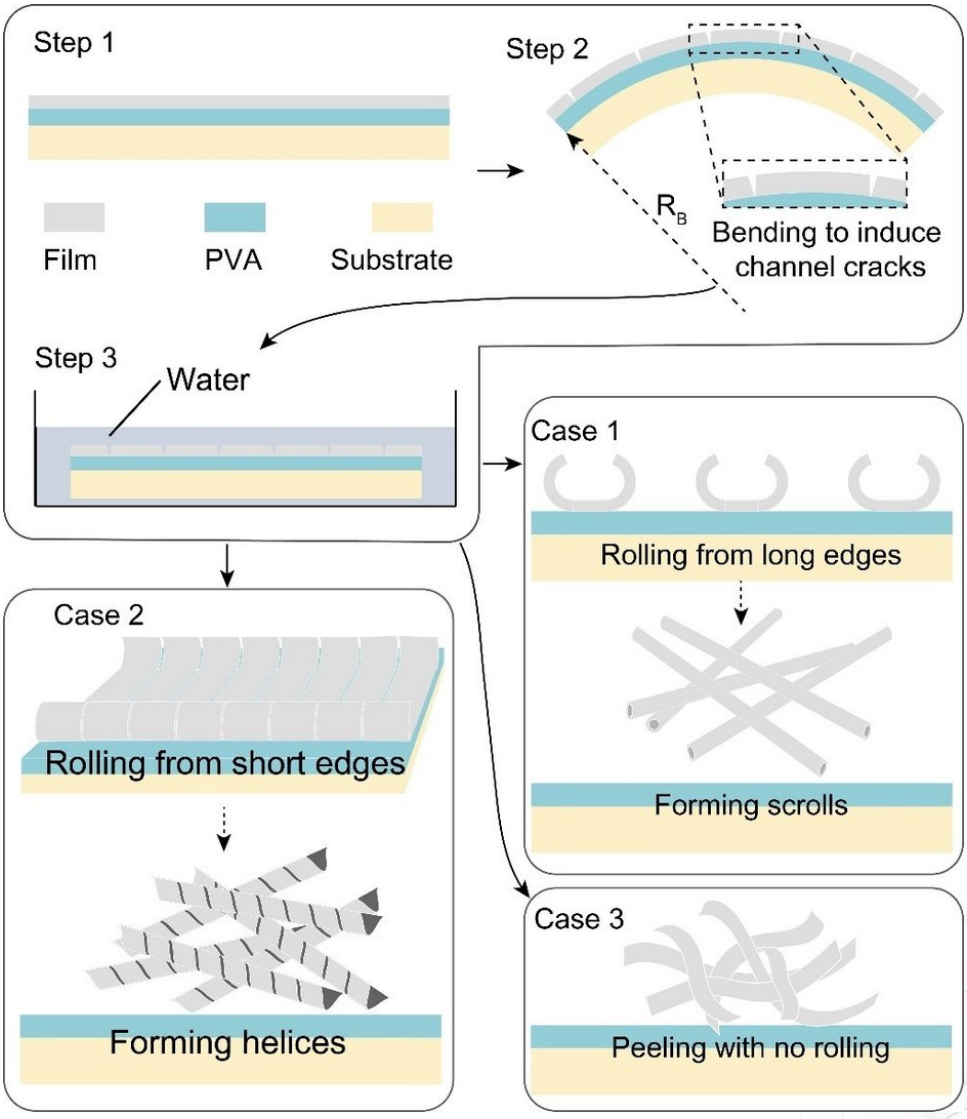

Figure 1. Schematic description for the developed synthesis method in this invention.

IP Status
Patent filed

Technology Readiness Level (TRL) 4

Inventor(s)

Prof. YANG Yong
Mr. WANG Tianyu
Mr. PARK Minhyuk
Mr. ZHANG Zhibo

Enquiry: kto@cityu.edu.hk

Opportunity

Nanodevices are machines that operate at the scale of atoms and molecules, with important applications in biomechanical engineering, micro-robotics, and optical engineering. The rapid development of state-of-the-art nanotechnology is driven by emerging nanofabrication methods, notably the self-rolling of 2D materials or nanosheets into tubes or helices. However, conventional chemical-based “roll-up” techniques, usually involving wet etching, are time-consuming, suffer from low fabrication efficiency, and

produce only simple, scroll-like structures, requiring engineers to make compromises. To unlock the potential of nanotechnology, it is crucial to find a way of shaping nanosheets swiftly, affordably and efficiently into high-precision tubular micro- and nano-structures. Such structures could accelerate the development of cutting-edge nanodevices for use in microjets, light-emitting resonators, novel optoelectronics, and more.

Technology

The invention is a novel, low-cost, and ultra-fast method of fabricating advanced metallic nano- and micro-structures, including ribbons, scrolls and helices, from various kinds of metals and alloys. Essentially, the new method entails twisting nanosheets in a controllable way. This process, known as polymer surface buckling enabled exfoliation, has four stages. First, nanosheets are coated in a polyvinyl alcohol (PVA) hydrogel layer, to which a metallic film is added. Next, the material is bent over a roller to which parallel channel cracks are applied to create the desired structure. It is then immersed in a layer of deionized water from which the PVA evaporates, leaving the completed structure. Unlike conventional methods of nanofabrication, such as photolithography, the novel approach uses no harmful chemicals, making it environmentally friendly. It is also much more time-efficient than existing methods, delivering results in just seconds rather than hours or days. In addition, the new approach offers engineers and designers control over the scroll-, ribbon- and helix-shaped structures of rolled nanosheets.

Advantages

- Fabrication is more cost-effective
- Fabrication is faster, taking seconds rather than hours or days
- Unlike methods based on photolithography and chemical etching, the new approach is chemical-free and thus environmentally friendly
- Engineers can control the structures of rolled nanosheets

Applications

- Development of advanced devices used in biomechanical engineering, micro-robotics, and optical engineering
- Development of new materials, targeting advanced composites and chemical catalysts
- Strengthening hyper elastic polymers for various engineering applications