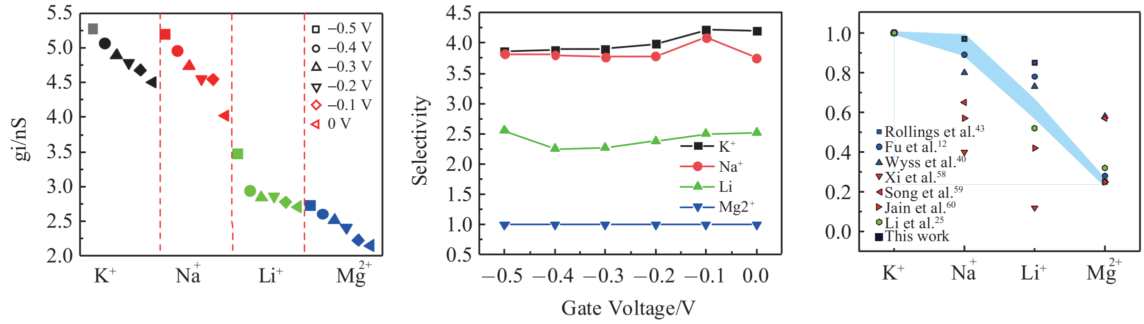

Fig. 2 (color online) Ion selectivity of G/PET nanochannel.

In summary, we have prepared a device for voltage-modulated ion transport through the graphene nanopore, which has a promising development in the field of bionic ion channels and monovalent and divalent cation separation. The G/PET nanochannel imitates the K^+ ions biological nanochannel, and K^+/ions selectivity up to ∼4.2. The modulation and monovalent/divalent cation selectivity of the G/PET nanochannel are determined by the electrical potential of the graphene nanopore and the surface of graphene. The excellent electrostatic modulation and ion selectivity ability of G/PET results from the interaction between the graphene nanopore and the conical PET nanochannels. One can modulate ions passing through the hybrid nanochannel by simply adjusting the gate voltage. The anions and cations in the electrolyte solution are accumulated/depleted by the electrical potential, and divalent cations are less susceptible to pass through the graphene nanopore compared to monovalent ions. This work ameliorates the problem of nanochannels that do not timely respond to selective electrostatic modulate ion transport. This heterogeneous structure can be fabricated rapidly and with extremely high yield. In addition, it can be produced in large quantities, which makes it another effective way to investigate the voltage gating effect in bionic channels and to perform ion selection and has great potential for commercial application.

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5 - 26 Study on Wearable SERS Sweat Sensor Based on Ion Track-etched Membrane

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In recent years, sensors that detect the chemical composition of human secretions can better respond to the level of relevant pathological components within the body[1,2], thus alerting individuals to potential diseases for early attention or giving doctors clinical aids for diagnosis. The use of metal nanoparticles with good LSPR effect and Raman spectroscopy allows for efficient and comprehensive composition analysis of human sweat[3,4].

In this work, a one-step in situ synthesis of AuNSs SERS substrates on PC ion-track etched membranes was proposed, and the morphology, distribution modulation and optimization of AuNSs were realized. Rapid collection and detection of the analytes were completed using the filtration method. The substrate was homogeneously prepared, and the signal was reproducible and reusable. Finally, the ion-track etched membranes were used for the first time for sweat composition analysis and non-invasive health monitoring.

Figure 1 shows the preparation process and detection of AuNSs/PC SERS substrates, and presents the corresponding SEM images. The results show that AuNSs are uniformly distributed and the pore channels are through. Additionally, the substrate also possesses good flexibility.

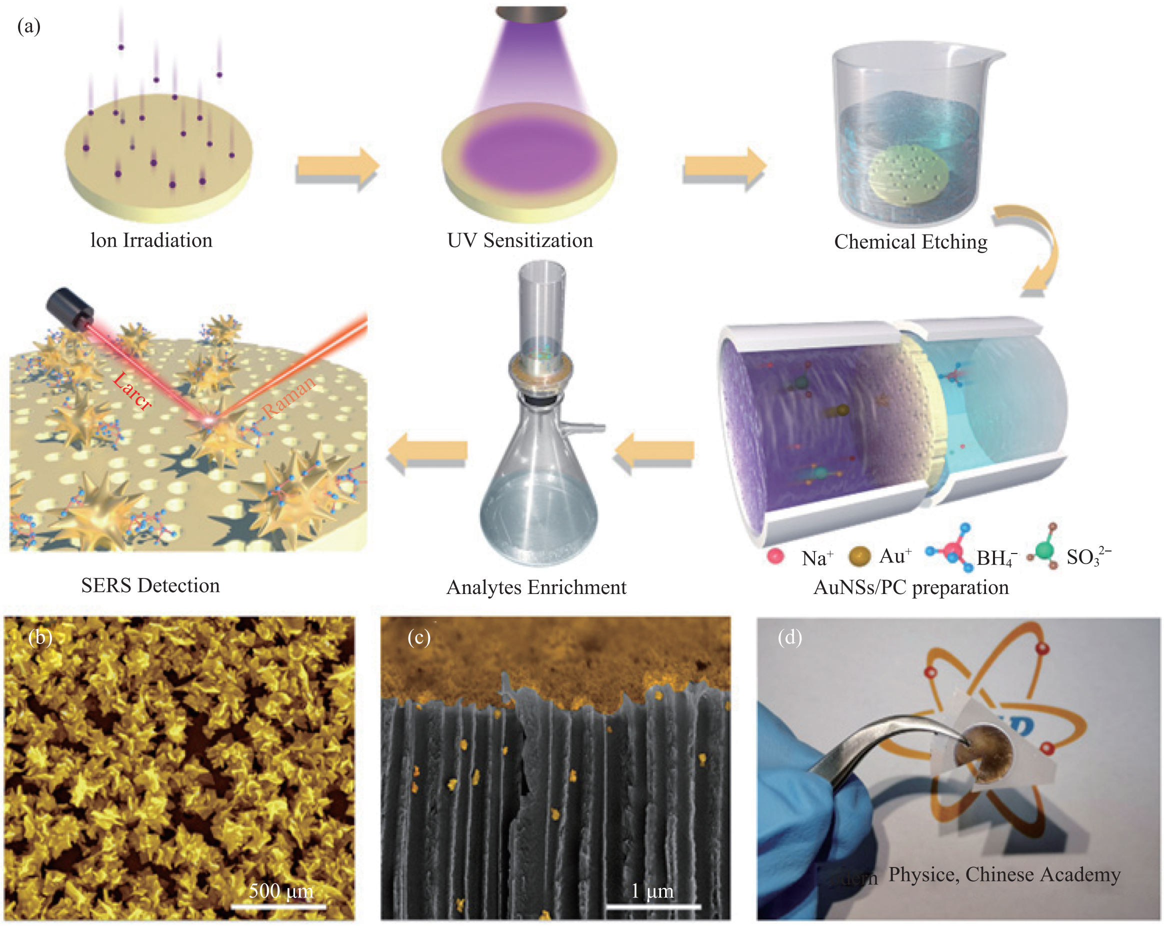

Fig. 1 (color online) (a) Schematic diagram of the preparation process of AuNSs/PC ion-track etched membrane SERS substrate and SERS detection. SEM images of the (b) Surface and (c) Cross-section of the AuNSs/PC SERS substrate, (d) Photographs of the AuNs/PC SERS substrate.

Figure 2 shows that AuNSs/PC SERS substrates can be used for the detecting of human sweat components and for health monitoring of relevant pathological components.

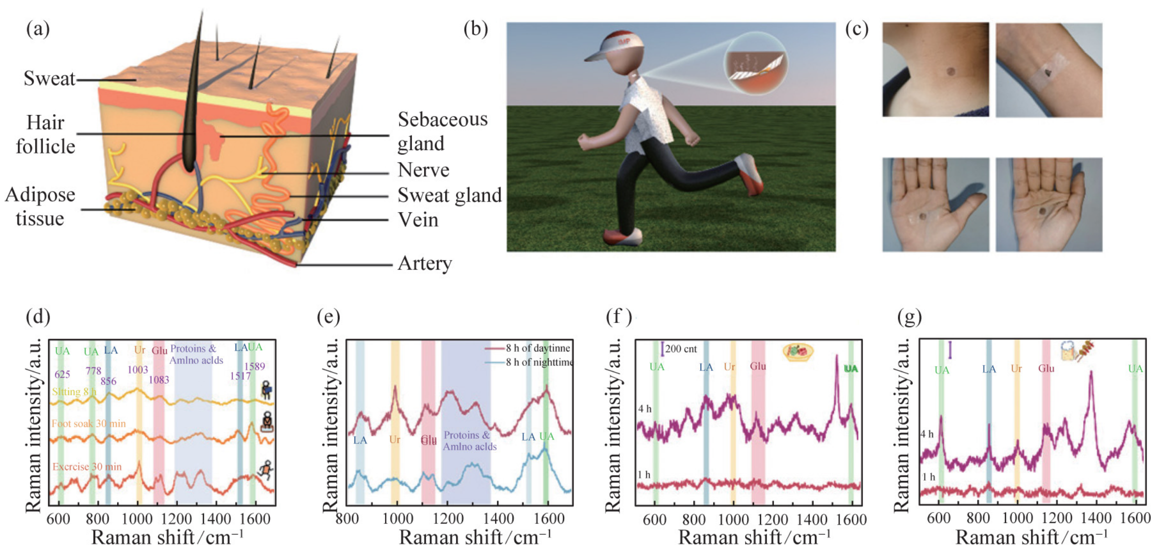

Fig. 2 (color online) (a) Schematic diagram of subcutaneous tissue structure and metabolic pathways of substances, (b) Diagram of the AuNSs/PC SERS substrate for sweat collection analysis, (c) Photos of SERS sensors worn on different parts of the body, (d) Sweat spectra obtained from SERS analysis in three different scenarios, (e) Changes in sweat composition during the day (normal activity) and night (sleep state). Changes in the composition of sweat after (f) a normal diet and (g) a high purine diet during the same time period.

In summary, a wearable and flexible nanoporous AuNSs/PC SERS substrate was designed by using the ion-track etched PC membrane as a reaction generator for synthesizing AuNSs on the membrane surface. The nanoporous SERS substrate displayed excellent SERS signal homogeneity. The prepared SERS substrate also exhibited good chemical stability and mechanical property. It can be used repeatedly by using the developed cleaning procedure to lower usage costs. Most importantly, benefiting from the nanoporous structure, the substrate can be adopted as a sweat sensor to monitor the contents (like uric acid, lactic acid, *et al.*) in human sweat even without liquid-form sweat releasing, which is extremely meaningful for the bedridden person or the people who could not do strenuous exercise to realize the non-invasive health monitoring.

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5 - 27 Ion Track-Based Low-Tortuosity and High-Porosity 3D Metallic Electrodes for Long-Life Lithium Anodes

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Lithium (Li) metal anodes are the most promising candidate for next-generation energy storage batteries with high energy-density. However, Li metal anodes suffer severe Li dendrite issues, signifficant capacity degradation as well as severe safety problem, which hinder their further commercial applications[1].

Numerous studies show that the uniformity of electric field highly affects the transfer rate of Li^+ and electrons and the local current density during Li deposition process, which in turn has an important effect on the formation of Li dendrites[2]. Therefore, 3D Li-host has been proposed as an effective strategy to relieve lithium dendrite issues, because 3D host (such as woven Cu mesh, 3D Cu foam, and 3D Ni foam) by utilizing the porosity of the electrode can effectively homogenize the electric field and Li^+ flux as well as availably relief the tremendous volume expansion during the charge-discharge processes. However, those Li-based composite anodes mainly possess random-arranged structure with high-tortuous pathways, leading to low ion transport and poor rate capabilities. Thus, it's highly desired to develop 3D Li-host anodes with low-tortuosity and high-porosity for high-power-density and high-energy-density.

In this report, based on ion track technology, a highly interconnected 3D Cu matrix with both low-tortuosity (1.3) and high-porosity (81.5 %) was fabricated to redistribute electric field and Li^+ flux in Li anodes (Fig. 1(a)). According to our new study[3], 3D Cu matrix could have excellent energy absorption capacity and compressive strength. Furthermore, 3D Cu matrix combined with lithiophilic $CuAu_x$ nanocrystals to form 3D metallic Cu&$CuAu_x$ matrix, which can highly lower the lithium nucleation barrier. As a consequence, due to its large surface area and ultrahigh porosity, the as-prepared 3D metallic Cu&$CuAu_x$ matrix can effectively reduce the local current density and Li nucleation barrier during Li deposition process. Furthermore, finite element simulation reveals that the unique 3D Cu&$CuAu_x$ structure can efficiently homogenize the electric field and Li-ion flux as well as reduce the lithium-ion concentration gradient in Li anodes. As a result, the composite 3D Cu&$CuAu_x$-Li anodes exhibit ultrahigh cycle life more than 2 100 hours (Fig. 1(b)). The long cycle life performance and rate capabilities significantly surpassed most of 3D hosts. As shown in Fig. 1(c), the full cells based on 3D Cu&$CuAu_x$-Li anodes and $LiFePO_4$ cathodes also demonstrate a stable cyclic performance (200th cycle) and have better capacity retention than Cu-Li//LFP and 3D Cu-Li//LFP.