neous on-substrate SERS detection.

References

[1] S. Alberti, A. Gladfelter, T. Mittag, Cell, 176(2019)419.
[2] J. Han, J. Fu, R. B. Schoch, Lab Chip, 8(2008)23.
[3] K. Kneipp, Y. Wang, H. Kneipp, et al., Phys. Rev. Lett., 78(1997)1667.

5 - 25 Single Graphene Nanopore for Biomimetic Ion Channel via Tunably Voltage-modulated Ion Transport

Zhao Zhuo[1,2], Guo Zaichao[1,2], Zhang Zhenhua[1,2], Gui Xiaoyu[1,2], Liang Zhihao[1,2], Liu Jie[1,2], Du Guanghua[1,2], Duan Jinglai[1,2,3] and Yao Huijun[1,2,3]

([1]Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China;
[2]University of Chinese Academy of Sciences, Beijing 100049, China;
[3]Advanced Energy Science and Technology Guangdong Laboratory, Huizhou 516000, Guangdong, China)

Biological ion channels possess a remarkable ability to selectively modulate ionic flux and play an irreplaceable role in many life processes[1]. The modulation of ion transport through nanopores or nanochannels has received considerable attention due to the similar transport mechanism of biological ion channels. Graphene has become the most promising membrane material because of its good permeability, mechanical strength and chemical stability. Based on its excellent electrical conductivity, it is possible to apply the gate voltage on the graphene to modulate ion transport through the graphene nanopore[2].

Herein, the graphene/polyethylene terephthalate (G/PET) composite nanochannel was prepared by swift heavy ion irradiation, and gate voltage was applied on it. The results exhibited that the transport of cations (K^+, Na^+, Li^+, Mg^{2+}) can be electrostatically modulated by the applied gate voltage. The G/PET nanochannel imitated the K^+ ions biological nanochannel and impedes the transport of divalent ions with K^+/ions selectivity up to ~4.2. Furthermore, it was confirmed by simulation that the applied gate voltage can change the electric potential around the graphene nanopore and the surface of the graphene. Therefore, the change of potential leads to the accumulation and depletion of anions and cations near the graphene nanopore and has the ability to modulate cations transport through the graphene nanopore. This work demonstrated that the graphene nanopore with applied gate voltage can effectively modulate ion transport and exhibit significant selectivity for monovalent and divalent cations. Figure 1 shows the structure of G/PET nanochannel, etching/measuring device and SEM images of graphene nanopore and PET nanopore. Figure 2 shows the Ion selectivity of G/PET nanochannel.

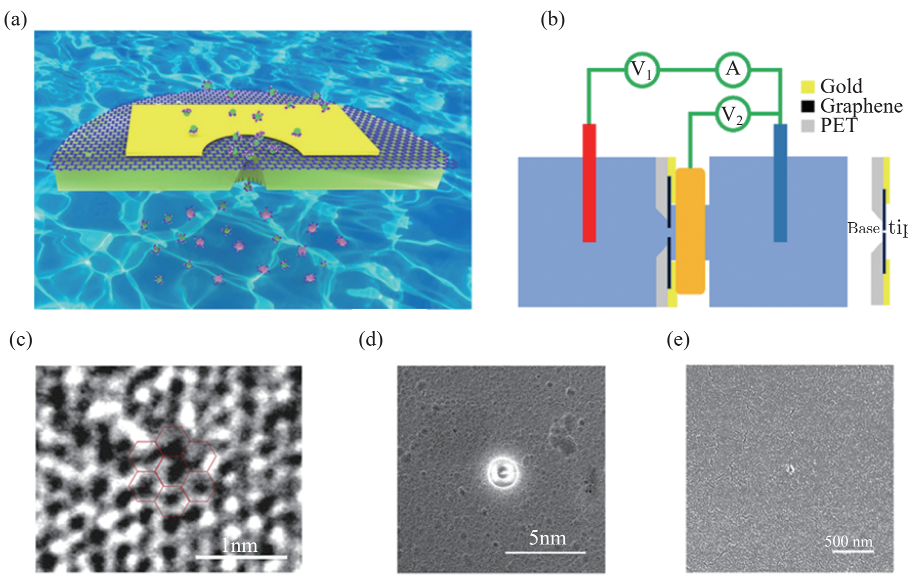

Fig. 1 Structure of G/PET nanochannel, etching/measuring device and SEM images of graphene nanopore and PET nanopore.

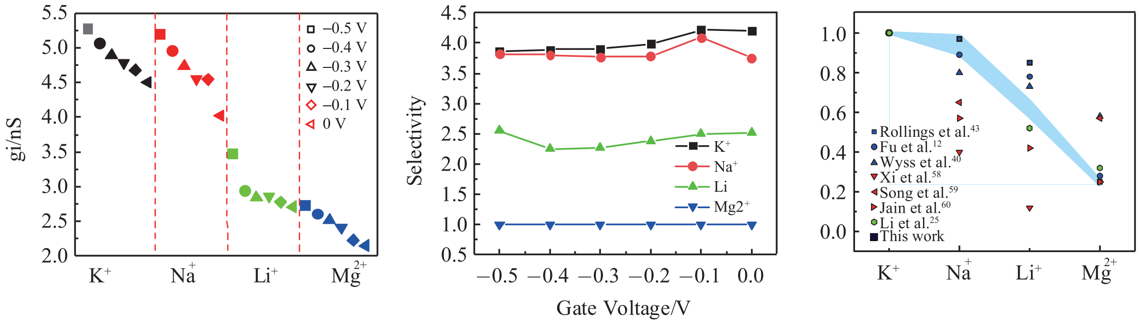

Fig. 2 (color online) Ion selectivity of G/PET nanochannel.

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.

References

[1] B. Hille, Ion Channels of Excitable Membranes, 3rd ed., Sinauer Associates, Inc, Sunderland, MA (2001).

[2] S. Su, Y. Zhang, S. Peng, et al., Nature Communications, 13(1)(2022).

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

Gui Xiaoyu[1,3], Xie Jianjun[1,3], Wang Wentao[1,2], Hou Borui[1,3], Zhai Pengfei[1], Tang Jiao[1], Wu Xuanxuan[1], Duan Jinglai[1,2,3], Liu Jie[1] and Yao Huijun[1,2,3]

([1]Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China;
[2]Advanced Energy Science and Technology Guangdong Laboratory, Huizhou 516000, Guangdong, China;
[3]University of Chinese Academy of Sciences, Beijing 100049, China)

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.