InP nanowire arrays for gas sensing applications

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Introduction

Gas sensors that can specifically detect and monitor gases over a broad range of concentrations and with high reliability are widely applied for air monitoring, disease diagnosis and industrial safety.[1] Due to their large surface-to-volume ratio, excellent electrical and optical property, tunable size and chemical composition,[2,3] III-V compound semiconductor nanowires offer a promising platform for next-generation sensing technology.[4]

In this work, we aim to fabricate ordered vertical InP semiconductor nanowire arrays for gas sensing applications by top-down etching method. Sensing performance of the devices can be enhanced by controlling the diameter, pitch size and surface functionalization of nanowires. The development of nanowire based high-performance gas sensors are promising for applications including diagnosis of type I Diabetes, one of the core projects of the OHIOH program.

Gas sensor and clinical diagnosis application

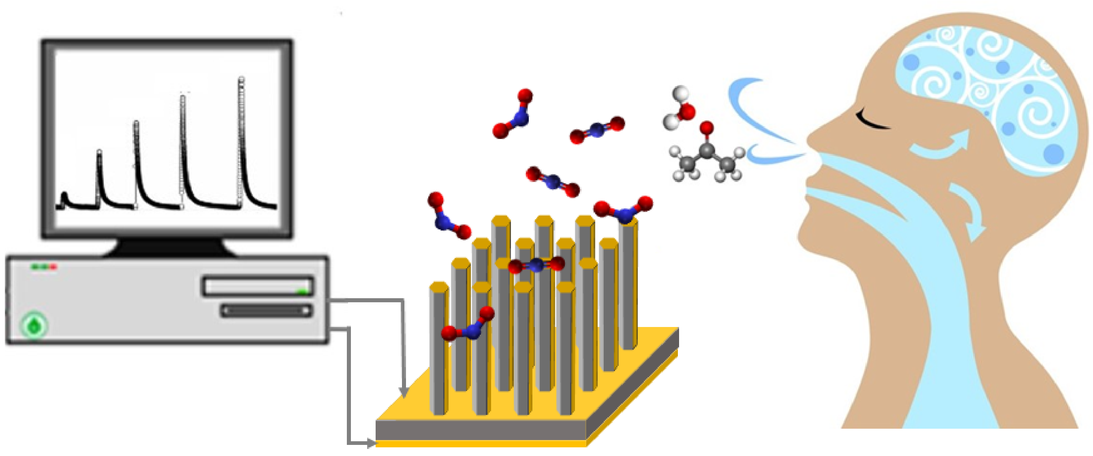


Figure 1. The schematic of gas sensor and its clinical diagnosis application.

Top-down etching process for nanowires array

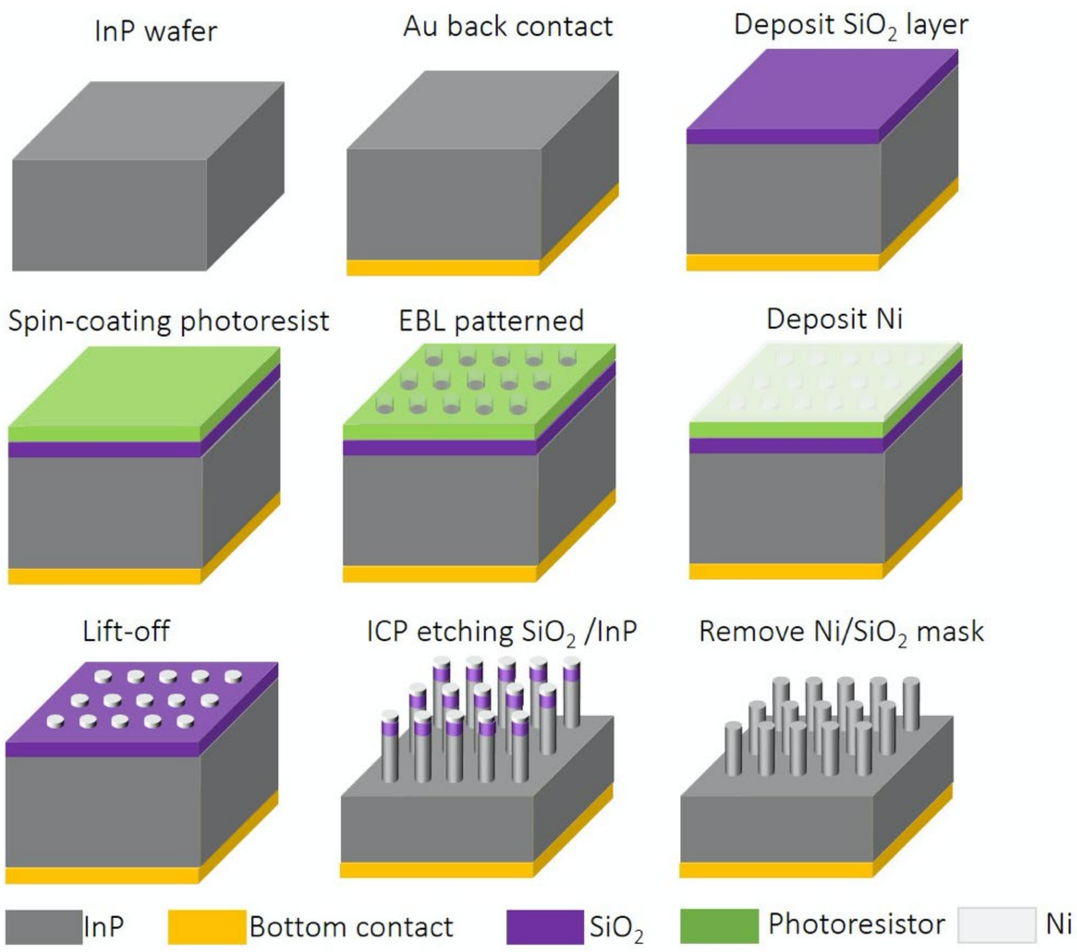
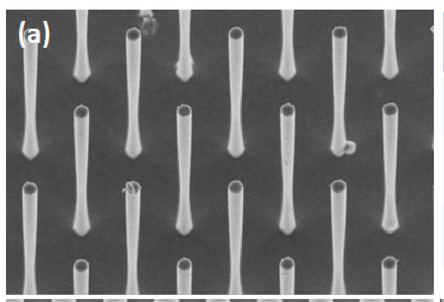


Figure 2. back contact and top-down etching process for fabrication of InP nanowires array

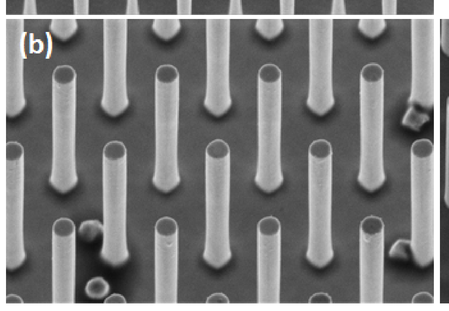
Conclusion

- The top-down etching method can fabricate InP nanowires arrays with precisely controlled diameter and pitch size.
- The InP nanowires arrays show a great potential as a high-performance NO_2 sensor.
- Surface functionalization will enhance the sensing performance and selectivity for exhale breath sensor which is promising for clinical diagnosis.

Scanning Electron Microscopic images of fabricated InP nanowires array



Sample	Diameter	Length	Pitch size
a	135 nm	2.26 µm	1 µm
b	215 nm	2.07 µm	1 µm
c	330 nm	1.94 µm	1 µm



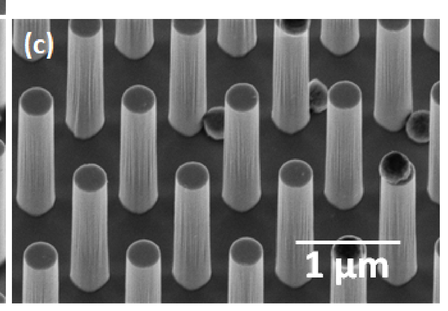
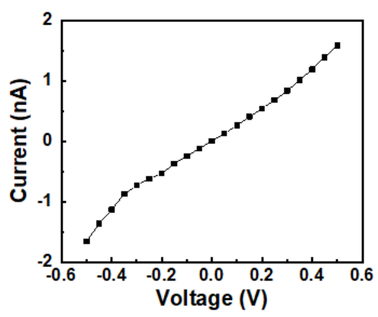


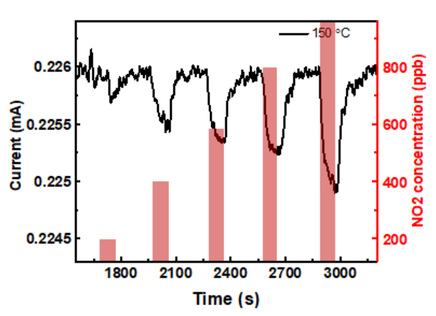
Figure 3. InP nanowires fabricated by top-down etching method.

Electrical and sensing performance

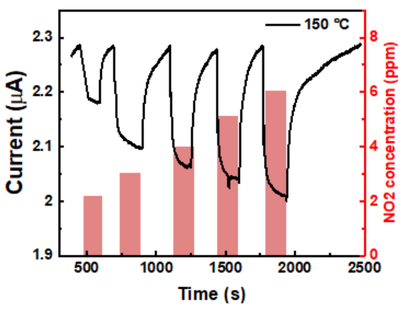
a. Ohimc contact



b. Current behavior with NO_2



c. Current behavior with NO_2



d. NO_2 sensing response

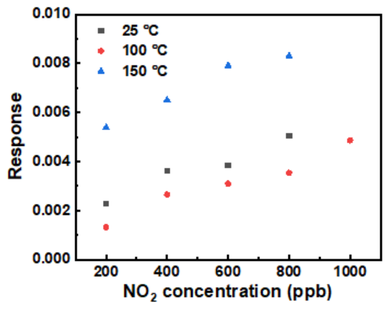


Figure 4. I-V measurement and NO_2 sensing measurement (response= $(I_{air}-I_{gas})/I_{air}$) based on the nanowires sample in figure 3a.

- The responses of NO_2 show a concentration dependence behavior and the limit of detection reach to 200 ppb.
- The room temperature sensing has been achieved.

Acknowledgment

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References

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