Diagnostic Biosensing: a Multimodal Breath Sensor

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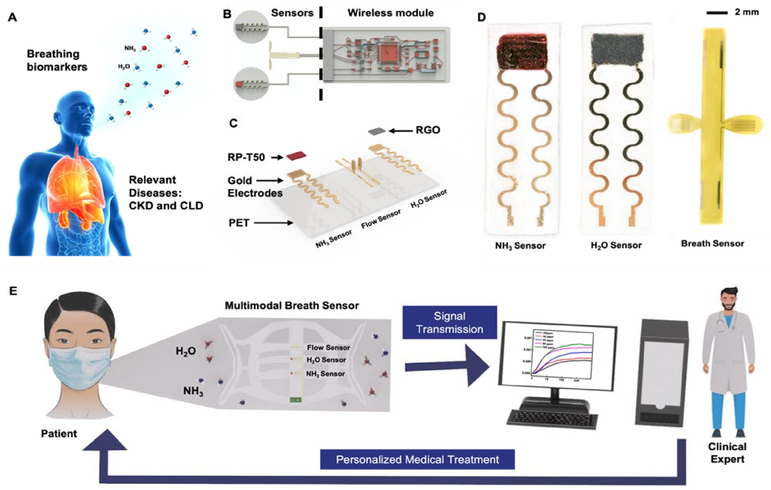
Abstract

- We present a multimodal breath sensing device that integrates:
  - Ammonia Sensor based on a conductive polymer (RT-P50-COOH).
  - Humidity Sensor based on a reduced graphene oxide (rGO) polymer.
  - Breath Dynamics Sensor based on a folded mesostructure.
- Operationally simple and practical, allowing noninvasive tracing of breath ammonia.
- Shows promising potential to capture early signs of organ dysfunctions for patients with CKD and CLD.

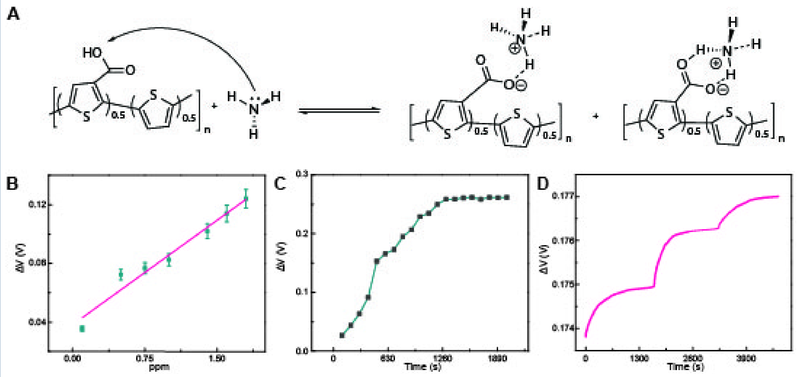
Background

- Breath ammonia can reach toxic amounts in patients with chronic liver disease (CLD) and chronic kidney disease (CKD). This can lead to fatal complications.
- Existing breath ammonia sensors fail to compensate for the impact of breath humidity and complex breathing motions associated with a human breath sample.
- In this work, we report a sensor that overcomes these challenges.

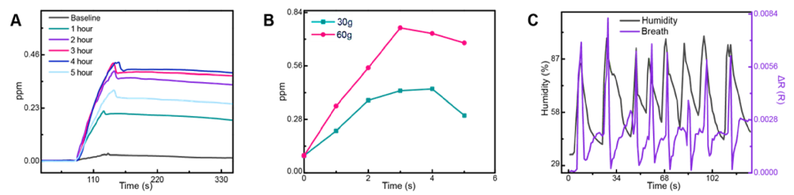
Results



Design of multi-modality breath sensor. **A**, Human breath sample containing essential biomarkers including ammonia and water. **B**, Multi-modality breath sensor that integrates an ammonia sensor, a humidity sensor, and a dynamics sensor with wireless transmission of sensing data. **C**, Exploded view of the sensor design. **D**, Images of each sensor. **E**, Ideal utility of the device. Breath data from the users can be extracted via signal-processing algorithms, then interpreted by medical professionals.



Characterization of an ammonia sensor based on RP-T50. A, The side chain on RP-T50-COOH interacts with ammonia through a reversible acid-base reaction. **B**, Calibration curve of an ammonia sensor based on an RP-T50 thin film in response to ammonia concentrations in the range relevant to human breath. **C,** Measurement of the sensor in response to ammonia gas **D,** Measurement of the ammonia sensor through a stepwise introduction of ammonia gas.



On-body testing of the full sensor. A, Ammonia sensing during a 30g protein ingestion experiment. **B**, Calculated ammonia production throughout the 30g and 60g protein ingestion experiments: the resultant breath ammonia showed a gradual decline in both experimental conditions. **C**, Simultaneous breath test with humidity and breath dynamics sensors.

Discussion

- The integration of the three sensors into a mask insert device provides real-time information about the health physiology of patients with CKD and CLD through wireless clinical reporting to enable personalized medical care.
- This form of translational biosensing allows an avenue for further studies into creating non-invasive detection methods and medical devices for diagnosis to provide a future of improved healthcare access.

Acknowledgements / References

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