

Binder-Free Printing Ultra-Stable PEDOT Sensor on Multiple Fabrics Using Oxidative Chemical Vapor Deposition

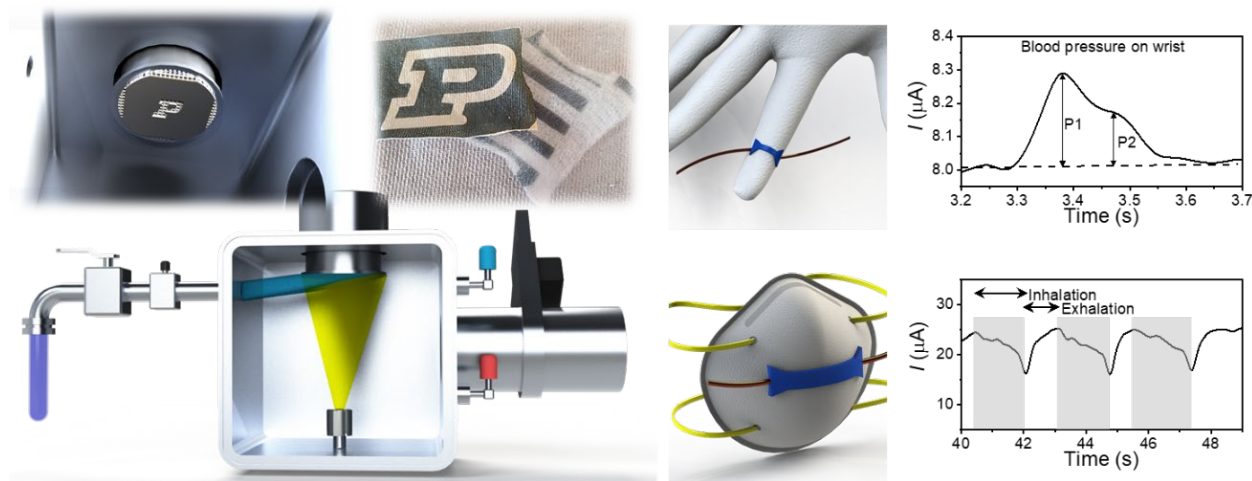
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With the dramatic progress of Internet-of-Things technology and Artificial Intelligence (AI) algorithms, portable healthcare monitoring has been highlighted as a facile pre-diagnosing strategy for tracking individual health status without hospitalization. In this regard, a wide range of wearable sensors, which extract bio-information such as body temperature, blood pressure, or respiratory patterns, have been developed so far. Although numerous factors are considered during sensor development depending on the types of analytes or target locations in the human body, acquiring sufficient flexibility must be a priority to endure uncontrollable stress caused by the surrounding conditions.

Diverse flexible materials have been exploited as suitable substrates for wearable sensors that fulfill the desired mechanical stability. Among them, textiles have tremendous advantages in terms of remarkable stability, skin compatibility, lightweight, and breathability. However, owing to their inherently rough surface, high porosity, and surface hydrophobicity, the formation of a uniform sensing film on fabric has been regarded as a much daunting task compared to a flat and rigid substrate. Liquid-phase coating methods such as spin-coating, dip-casting, or doctor-blading have failed to create a uniform and reproducible film on a fabric. Additives like binders are sometimes effective for improving conformability, but creating thin layers, which is significant for high-performance sensors, still remains challenging. Vapor phase coating methods are, arguably, the most efficient tactics for coating sensing films on fabrics. Inorganic or metallic materials, deposited by a comprehensive deposition tool based on physical vapor deposition, chemical vapor deposition, or atomic layer deposition techniques, have been typically considered as active materials for strain sensors, thermometers, or pressure sensors. However, the inorganic materials with poor flexibility or stretchability are vulnerable to be cracked readily even under mild mechanical stress. Thus, exploring materials and contriving their proper coating methods should be further progressed for realizing desired fabric-based wearable sensors.

Herein, we utilize the oxidative chemical vapor deposition (oCVD) technique for creating a conformal Poly(3,4-ethylene dioxythiophene) (PEDOT) layer on multiple fabrics (nylon, polyester, and cotton) without any binder or additives. The oCVD is capable of creating a highly conductive PEDOT (nominally, $1\text{--}10\text{ S cm}^{-1}$ on cotton fabric; $500\text{--}1500\text{ S cm}^{-1}$ on glasses) of which thickness is readily controllable from 50 nm to 1 μm by varying the deposition time. Moreover, the mechanical stability, breathability, and lightness of fabrics are consistent even after PEDOT coating, implying the oCVD could form a promising sensing material while maintaining all advantages of fabrics. Based on the unique properties of excellent conformality, high conductivity,

and good mechanical flexibility¹⁻⁵, we fabricate simple resistive-typed sensors by directly printing the PEDOT on a commercial glove and disposable mask, consisting of polymers such as polypropylene or polyester. The glove and mask sensors are capable of extracting blood pressure information and respiratory rates in real-time with remarkable precision. This is the first report proving the usability of the oCVD method on fabric-based sensors, thus, paving the way for developing versatile healthcare devices.



References

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