OR13

Assessing face mask barrier integrity with printed PEDOT:PSS sensor in Covid-19 pandemics

Marina Galliani[a], Laura M. Ferrari [b], Esma Ismailova[a]
[a]Mines Saint-Etienne, Centre CMP, Departement BEL, F - 13541 Gardanne France
[b]Université Côte d'Azur, 06902, Sophia Antipolis, (France)
marina.galliani@emse.fr, laura.ferrari@inria.fr, ismailova@emse.fr

With Covid-19 pandemic outbreak, the entire world faced multilevel healthcare system management challenges where the emergence to enable proper protection measures against infectious agents became critical. Face masks have been the most recommended personal protective equipment to limit the spreading of the infection. The guidelines of the World Health Organization on the use of masks in the context of Covid-19 stated that they should be replaced "as soon as they become damp".[1] To alert the user about the barrier integrity of the mask and monitor the user's breathing, we developed a multimodal humidity sensor on a facial mask (e-mask) able to monitor both the mask dampness and the respiration rate. Such an imperceptible e-mask is made by the direct inkjet printing a conductive polymer ink (PEDOT:PSS) in the shape of two interdigitated electrodes on the filter layer of the mask (Figure 1).

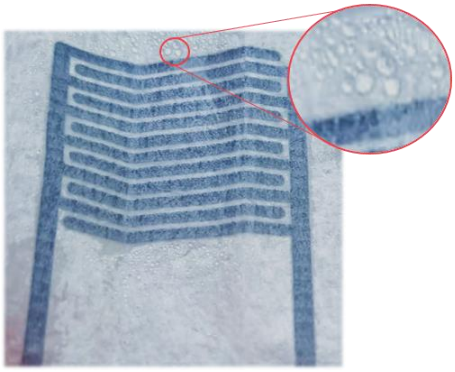

Figure 1: Picture of the PEDOT:PSS sensor printed on the face mask substrate.

By measuring the change in conductance between the two electrodes, we are able to follow the wetting level of the mask to assist the user in safe mask management. Moreover, we monitor the respiration rate, which can identify important symptoms of respiratory tract infection such as difficulty or short breathing. Humidity chamber tests and a dedicated aerosol flow set-up allow assessing the sensor's sensitivity in the targeted humidity range related to the integrity failure (above 90%). A wearable proof of concept is demonstrated using commercially available Bluetooth electronics. We test the e-mask in a real-life scenario when the user performs daily activities and physical exercise. The e-mask shows multimodal high-quality performances, it is stable towards body motion artifacts and does not impair the regular mask gas permeability. Therefore, we demonstrated the feasibility of a built-in unobtrusive sensor to directly monitor facial masks barrier integrity in real-time. Thanks to the adopted fabrication method and use of biocompatible [2] PEDOT:PSS, the sensor is safe and does not hinder the mask's filtering capabilities for the user. It can also be produced in a fast and scalable manner. [3]

[1] WHO, "Advice on the use of masks in the context of COVID-19," *Who*, no. April, pp. 1–5, 2020, [Online]. Available: https://www.who.int/publications-.

OR13

[2] Z. Rahimzadeh, S. M. Naghib, Y. Zare, and K. Y. Rhee, "An overview on the synthesis and recent applications of conducting poly(3,4-ethylenedioxythiophene) (PEDOT) in industry and biomedicine," *J. Mater. Sci.*, vol. 55, no. 18, pp. 7575–7611, 2020, doi: 10.1007/s10853-020-04561-2.

[3] M. Magliulo *et al.*, "Printable and flexible electronics: From TFTs to bioelectronic devices," *J. Mater. Chem. C*, vol. 3, no. 48, pp. 12347–12363, 2015, doi: 10.1039/c5tc02737c.