Interfacial engineering and structure control for highly sensitive nanocellulose quartz crystal microbalance humidity sensor

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Cellulose, a highly hydrophilic, abundant, and renewable bioresource, is emerging as an effective humidity sensing material. Cellulose coated on Quartz crystal microbalance (QCM) as humidity sensor is attracting scientific attention recently. Many researchers have modified functional group of cellulose as well as combined cellulose with polymer or carbon materials to further increase the sensing performance of cellulose coated QCM sensors. But few research has studied the interfacial effect between the electrode and the sensing layer. Because of the insufficient adhesive strength between the cellulose and the Au electrode of QCM, a robust adhesive layer is worthy of investigation to enhance the stability and sensitivity of the sensors.

Herein, a Quartz crystal microbalance (QCM) sensor coated with metal oxide thin film and 2,2,6,6-tetramethylpiperidine-1-oxyl radical (TEMPO)-oxidized cellulose which contains abundant carboxy acid groups has been fabricated as a humidity sensor by simple dropping and oven drying method. Four types of metal oxide species are fabricated at Au electrode of QCM sensor via radio frequency sputtering as interfacial layer, including Nickel Oxide (NiO), Zinc Oxide (ZnO), Titanium Oxide (TiO_2), Tungsten Trioxide (WO_3). The NiO interfacial layer shows better humidity sensitivity enhancement, owing to its higher basicity and hydrophobicity, leading to intensive bulk shape of dispersion solution, resulting in denser and thicker sensing film of cellulose on QCM. To study the enhancement mechanism, the bulk shape of sensing film, the hydrophilicity of metal oxides interfacial layer was studied.