Fabrication of MOF-on-Inorganic Material Heterostructure Thin Film for n-Alkane Recognition Sensor

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Metal-organic Frameworks (MOFs) are characterized by their highly porous structures, which endow them with exceptional adsorption capabilities [1]. Therefore, integrating MOFs into sensors, such as quartz crystal microbalance (QCM) systems, presents significant potential for practical applications in molecular detection [2]. However, conventional fabrication techniques like drop-casting lead to poor interfacial adhesion, which limits the potential of adsorption properties. Here, we present a unique MOF-on-inorganic heterostructure layer directly grown on a QCM substrate. Aided by the inorganic adhesion layer, this structure allows the shear-mode vibration to propagate effectively through the sensing layer to encode MOF's molecular adsorption events accurately. As a proof-of-concept, this MOF-integrated QCM sensor was exposed to trace amounts of n-alkanes (hexane, heptane, octane). The sensor exhibits high signal-to-noise ratios, which are 80 times higher than drop-casted prepared sensors, and demonstrates a response to n-alkanes that outperforms previously reported sensors by several orders of magnitude.

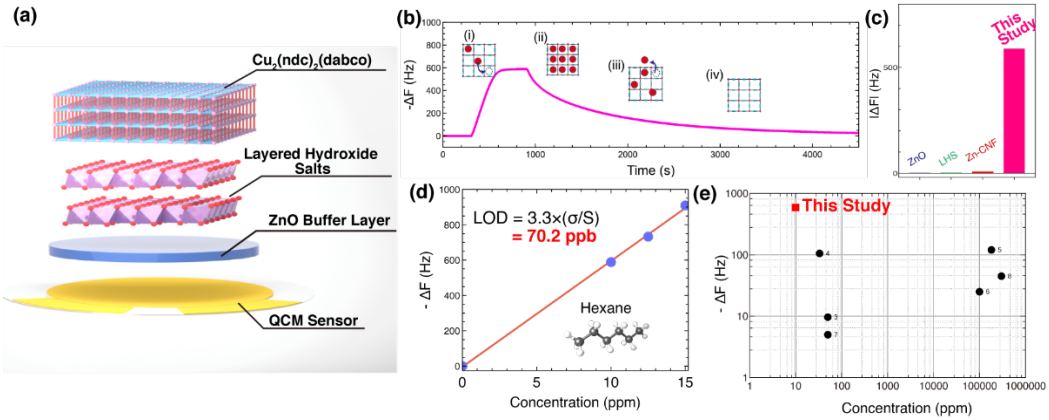

Figure. (a) Illustration of the overall structure of MOF-inorganic heterostructure-based QCM sensor. (b) Kinetics of the sensor response to 10 ppm hexane. (c) Comparison of the response of different sensing materials to 10 ppm hexane.(d) The limit of detection (LOD) for hexane was calculated to be less than 100 ppb. (e) Comparison with previously reported hexane sensors [3][4][5][6][7][8].

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