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Vertical nanogap arrays assembled from nanoenti ties for highly sensitive biochemical detection

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Nanogap-based biosensors have emerged as promising platforms for detecting and measuring biochemical substances at low concentrations. Although the nanogap biosensors provide high sensitivity, low limit of detection (LOD), and enhanced signal strength, it requires arduous fabrication processes and costly equipment to obtain micro/nanoelectrodes with extremely narrow gaps in a controlled manner. In this work, we report the novel design and fabrication processes to construct vertical nanogap structures that can electrically detect and quantify low-concentration biochemical substances. By magnetically assembling bioreceptor-functionalized nanowires onto a nanodisk patterned between a pair of microelectrodes, ~40-nm gaps are facilely formed between the nanowires and the microelectrodes. Analyte molecules attached to conductive gold nanoparticles are captured and bound to the surface of the nanowires and bridge over the nanogaps, which consequently causes an abrupt change in the electrical conductivity measured between the microelectrodes. Using biotin and streptavidin as model bioreceptors and analytes, we demonstrate that our nanogap biosensors can effectively measure the protein analytes with the LOD and sensitivity determined as 31 pM and 61.8 nA/pM. The outcome of this research could inspire the design and fabrication of nanogap electrical devices and nanobiosensors, and it would have a broad impact on the development of microfluidics, biochips, and lab-on-a-chip architectures.