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Sensing Endocrine Disrupting Chemicals by Virus-Based Structural Colour Nanostructure

Authors : Lee Yujin, Han Jiye, Oh Jin-Woo

Abstract : The adverse effects of endocrine disrupting chemicals (EDCs) has attracted considerable public interests. The benzene-like EDCs structure mimics the mechanisms of hormones naturally occurring in vivo, and alters physiological function of the endocrine system. Although, some of the most representative EDCs such as polychlorinated biphenyls (PCBs) and phthalates compounds already have been prohibited to produce and use in many countries, however, PCBs and phthalates in plastic products as flame retardant and plasticizer are still circulated nowadays. EDCs can be released from products while using and discarding, and it causes serious environmental and health issues. Here, we developed virus-based structurally coloured nanostructure that can detect minute EDCs concentration sensitively and selectively. These structurally coloured nanostructure exhibits characteristic angel-independent colors due to the regular virus bundle structure formation through simple pulling technique. The designed number of different colour bands can be formed through controlling concentration of virus solution and pulling speed. The virus, M-13 bacteriophage, was genetically engineered to react with specific ECDs, typically PCBs and phthalates. M-13 bacteriophage surface (pVIII major coat protein) was decorated with benzene derivative binding peptides (WHW) through phage library method. In the initial assessment, virus-based color sensor was exposed to several organic chemicals including benzene, toluene, phenol, chlorobenzene, and phthalic anhydride. Along with the selectivity evaluation of virus-based colour sensor, it also been tested for sensitivity. 10 to 300 ppm of phthalic anhydride and chlorobenzene were detected by colour sensor, and showed the significant sensitivity with about 90 of dissociation constant. Noteworthy, all measurements were analyzed through principal component analysis (PCA) and linear discrimination analysis (LDA), and exhibited clear discrimination ability upon exposure to 2 categories of EDCs (PCBs and phthalates). Because of its easy fabrication, high sensitivity, and the superior selectivity, M-13 bacteriophage-based color sensor could be a simple and reliable portable sensing system for environmental monitoring, healthcare, social security, and so on.

Keywords : M-13 bacteriophage, colour sensor, genetic engineering, EDCs
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