A smart 3-in-1 molecular device can do: detection, recognition and elimination of toxic cyanide

Cyanide is a useful but danger chemical. It is commonly use in industrial activities, such as mining, metallurgy, and photographic processing, however, one percent of tea spoon amount could cause a fatality to a normal human being. An estimation reveals that the total production of cyanide worldwide is about 1.4 million tonnes per year. Since 1975, more than 30 large-scale incidents involving significant contamination of water sources have resulted in severe financial, political, and health costs. Decades on, the issue remains unsolved.

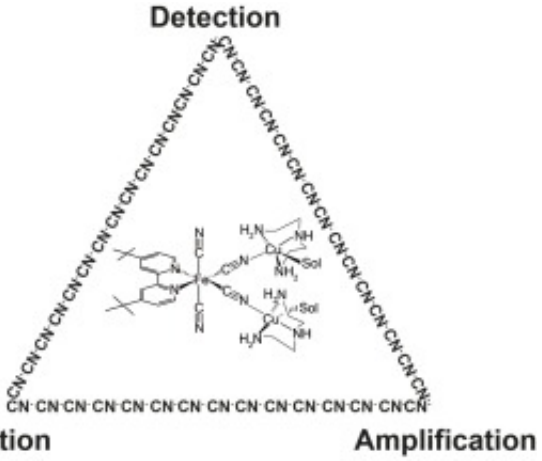

Fig. 1. A 3-in-1 molecular device capable of detection, recognition and elimination of cyanide.

But the situation is changing, a research team from The Hong Kong Institute of Education (HKIEd) has successfully invented a 3-in-1 molecular device with multi-functions: “Detection, Amplification of signal, and Elimination” for handling of trace cyanide ions found in water. The research work funded by the Hong Kong Research Grants Council was published in *Chemistry A European Journal* **2015**, *21*, 12984.

This new technology is developed through a special molecular design, called indicator/catalyst displacement assay (ICDA), multifunctional properties were incorporated into an iron-copper containing supramolecule. The device when detecting cyanide in the water bodies will give naked eye observable color signal and subsequently degrades the cyanide. The device is even smart enough to degrade the pollutant automatically when cyanide reaches a particular level.

The results obtained in this study show that the device can provide excellent performance in three tasks: (1) the production of visual colorimetric responses specifically for cyanide ions in aqueous systems without interference from other relevant interferences such as SO_4^{2-}, HCO_3^-, HPO_4^{2-}, N_3^-,

CH_3COO^-, NCS^-, NO_3^-, and Cl^-; (2) the sensitive detection of cyanide down to ppb level (the visual and method detection limit as 0.4 ppm and 9.5 ppb respectively); and (3) the complete oxidization of cyanide ions into the safer and more environmentally friendly chemical, cyanate (OCN^-). Moreover, these multifunctional assays were found to be workable in different water sources such as from taps, rivers, lakes, and underground water bodies.

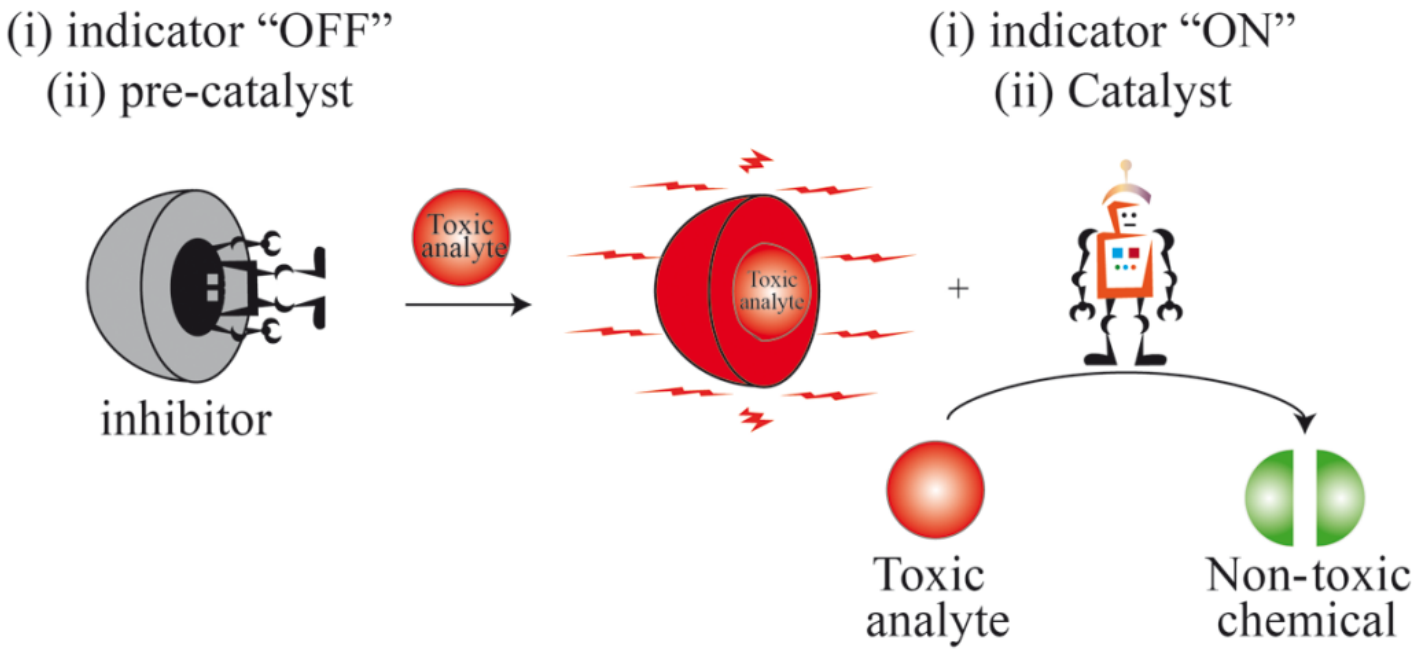

Fig. 2. Schematic diagram of the "indicator/catalyst displacement assays" (ICDA).

This discovery may shed new light on how to real-time monitor and treat other dangerous chemical wastes. The scientific background of how the device can take up multi-functions simultaneously for detection, amplification, and elimination upon detection of cyanide is now understood. The researchers will further explore the feasibility of designing other new smart devices for detection and degradation of various hazardous chemical wastes, such as oxalate, azo dyes, carboxylic acids, and organophosphate pesticides. Finally, the team will continue to establish this new technology on the complicated industrial wastewaters, which is composed of a mixture of the toxics rather at high concentrations.

Publication

A Multifunctional Bimetallic Molecular Device for Ultrasensitive Detection, Naked-Eye Recognition, and Elimination of Cyanide Ions

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