Amgen Seminar Series in Chemical Engineering

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Fluorescence Detection of Explosives: A Study Towards Optimization of a Thin Film Optical Sensor

By

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The threat of terrorists using explosive devices in nearly any location has led to a world wide effort to improve detection of all types of explosives. The challenge is that nearly all explosives have room temperature vapor pressures in the parts per billion or parts per trillion range, so any detector must be able to detect picogram (or less) quantities of analyte in a dirty background. The state-of-the-art commercial instrument, FIDO, uses fluorescent detection and is exquisitely sensitive. However, despite the high sensitivity, fluorescence suffers from poor selectivity so false alarms are a serious problem. Selectivity can be improved by chemically synthesizing fluorophores designed to target specific analytes but this leads to highly expensive systems. Our approach has been to use off-the-shelf laser dyes that have high quantum yields and to create arrays to provide selectivity. By using a layered thin film design (mechanical substrate – transparent polymer – fluorophore) the intensity of the emitted light can be amplified by two or three orders of magnitude, which will allow inexpensive optics to be used in a hand held instrument. This talk will focus on the underlying photophysics that allows the sensing to be both sensitive and selective. Submonolayer thin films of the fluorophores are readily detected because of the amplification mechanism. Consequently, the amount of explosive analyte required to perturb the fluorescence is equally small. The fluorescence emission can also be affected by the substrate onto which the fluorophore is deposited. The polarity and the thickness of the polymer modulate the emissive response and examples of this will be shown. The combination of fluorophore and polymer properties can be used to create arrays that are both sensitive and selective using readily available and inexpensive materials.

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