Nanoscale Optical Filters for Heavy Metal Monitoring

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Introduction

Heavy metal contamination is a concern for environmental safety and health. Heavy metals of considerable importance include Cadmium (Cd) and Zinc (Zn) which are under federal regulation because they can cause detrimental health effects in humans. Contamination can be caused by natural weathering of soil parent material which contains heavy metals. These metals can also be released into the environment through point and non-point pollution. Subsequent accumulation in the soil can reach toxic levels that lead to mortality of flora and fauna on the site or contamination of the food-chain.

One way of monitoring heavy metals is to use proteins produced from one gene that contributes to the accumulation of metal. This technology was effectively used in rat cells to monitor glutamate concentrations and in *E. coli* to monitor ribose uptake and metabolism. Real-time monitoring of glutamate was conducted by fusing two fluorescent proteins (FP) with different emission spectrums to either end of a native glutamate-binding protein. As conformational changes occurred due to glutamate binding, the spectral emissions from the two termini changed. This change in emission was then 1) detected with a sensor and 2) correlated with the glutamate concentrations.

In this study, several nano-scale filters based on frequency selective volumes were designed to be used in the optical sensor. A mixed order tangential vector finite elements up to order 2.5 were implemented in the finite element domain in order to improve the accuracy and reduce the computational time. Each FSV screen consisted of many unit cells; the geometry and size of these cells determines the response of the filter. Results regarding FSV filters composed of single or multi layer screens for green and red light detection will be presented.