Thesis: Photocatalytic Mineralization of Trichloroethlyene by Carbon Quantum-Dot Decorated Bismuth Oxyhalide

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Trichloroethylene (TCE) has been used in United States since the early 20th century for a wide array of industrial applications, including extraction solvent, a precursor for chlorine-containing organic compounds, spot removers, and metal degreasers. As a result of historical use and the physical properties of TCE, it is the most abundant contaminant in the US groundwater. In 2015 the Environment Watch Group (EWG) estimated that TCE contaminated drinking water affects 20 million people served by 458 municipal water systems across 20 states. Due to private wells not being tested like municipalities, the number of affected people is likely higher. The US EPA designates TCE as a known carcinogen and is considered carcinogenic by all routes of exposure. Current remediation methodology for TCE uses "air-striping," which takes advantage of TCE's low Henry's Law Constant moving TCE from the water to the air where it has an atmospheric half-life of a week and potentially exposing people who inhale TCE. A growing area of interest is semiconductor photocatalysis for the

remediation of organic pollutants to mineralize these pollutants to carbon dioxide and water. This thesis describes the synthesis of a family of semiconductor photocatalysts based on bismuth oxyhalides (BiOX, X = Cl, Br, or I) carbon quantum dots composites. Various bismuth oxyhalides were prepared by a surfactant-assisted low-temperature approach. Carbon quantum dots were synthesized via a microwave-assisted method and a hydrothermal procedure. The catalytic activity of various photocatalysts was evaluated in the degradation of rhodamine B dye. Different ensembles of CDs/BiOXs were explored for optimum photocatalytic activity. Furthermore, BiOCl, BiOBr, and BiOI photocatalysts were employed in the oxidative and reductive degradation of (TCE). BiOCl photocatalyst demonstrated promising results toward the complete mineralization of TCE. Of the three bare photocatalysts, BiOCl performed the best with BiOBr performing similarly well. BiOI had much lower activity, however, the activity of BiOI did improve with calcination. BiOCl was able to fully degrade TCE in 5 hours the under oxidative degradation, BiOBr and BiOI were unable to degrade TCE under these conditions. Both BiOCl and BiOBr were able to degrade TCE under reductive dehalogenation, however, BiOI was unable to degrade TCE under these conditions.