ABSTRACT

Su, Dan M.S.E., Purdue University, May 2013. Photo Mineralization of Aqueous Fullerene Clusters: Headspace Analysis and Product Characterization.

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Buckminsterfullerene (C_{60}) is an important fullerene material that has drawn much attention and is currently being applied in many different fields. It was discovered in 1985. As its production has largely increased to meet these industrial needs, it is obvious that its environmental occurrence, especially in aqueous systems, will occur. To further provide information for environmental toxicity studies and for its risk assessment, this thesis focuses on the photo transformation processes of aqueous C_{60} clusters (Aqu/nC_{60}), with a particular interest in measuring any mineralization that occurs under different irradiation conditions. Two sets of experiments were conducted to test for CO_2 production from Aqu/nC_{60}: Irradiation under solar light and irradiation under lamp light within a photo reactor. Both experiments suggest that CO_2 is produced from Aqu/nC_{60}, indicating that mineralization does occur to some extent. Due to the different light sources and experimental conditions, the rates for photo transformation and mineralization were different. In the solar light experiment, as much as 9% of the original C_{60}-carbon (0.148 mg) was transformed to inorganic carbon; and for the lamp irradiation study with a higher initial C_{60} mass (0.485 mg), as much as 14% of the carbon was converted to CO_2. Additionally, the Aqu/nC_{60} cluster size, zeta potential, UV/Visible absorbance, and reaction products were measured or observed. The solution pH proved to be a crucial factor, as a decreasing pH facilitated aggregation of clusters, influencing the stability of Aqu/nC_{60}. In buffered solutions, the clusters were more stable upon irradiation. It should be expected that the bioavailability and toxicity of C_{60} will change upon photoreaction. Liquid chromatographic

separation of the toluene extraction of the photo-reacted suspensions indicated new peaks, and some of these C_{60} photo-products have slightly higher polarity. This is the first study that indicates CO_2 is products from Aqu/nC_{60} clusters under photo irradiation by solar light, indicating that the 60 carbon atom structure of C_{60} is destroyed upon exposure to sunlight.