Effect of Natural Organic Matter on the Light-initiated Transformation of Fullerenes

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Natural organic matter (NOM) is ubiquitous in natural environments. Previous research has observed enhanced dispersion of Buckminster fullerene (C_{60}) in water in the presence of NOM. It is also well-known that NOM can impact the photoreaction of many organic compounds by producing reactive oxygen species (ROS) such as, singlet oxygen ($^1O_2$), superoxide (O_2^-) and hydroxyl radical ($\bullet$OH). Here we show that the phototransformations of C_{60} and fullerenol have very different dependencies on NOM concentrations. Corrected for light attenuation effects, C_{60} photoreaction rates generally decreased on addition of NOM but fullerenol rates were enhanced compared to controls without added NOM. Determination of $^1O_2$, O_2^- and $\bullet$OH in the C_{60}/NOM and fullerenol/NOM systems during irradiation suggested that photoreaction via ROS in the bulk water is not a major pathway for both C_{60} and fullerenol, but an intramolecular pathway in aggregates is potentially possible. Although NOM can act as both scavenger and generator of ROS, the balance between scavenging and generation of ROS may be altered because of microheterogeneous formation and reactions of the transients in fullerene or fullerene-NOM clusters.