Light-induced aggregation of microbial exopolymeric substances

LUNI SUN,[1] CHEN XU,[1] SAIJIN ZHANG,[1] PENG LIN,[1] KATHLEEN A. SCHWEHR,[1] ANTONIETTA QUIGG,[2] MENG-HSUEN CHIU,[3] WEI-CHUN CHIN,[3] PETER H. SANTSCHI[1]

[1] Dept. of Marine Science, Texas A & M University at Galveston, Galveston, TX 77553, USA
[2] Dept. of Marine Biology, Texas A & M University at Galveston, Galveston, TX 77553, USA
[3] School of Engineering, University of California at Merced, Merced, CA 95344, USA

Sunlight can inhibit or disrupt the aggregation process of marine colloids via cleavage of high molecular weight compounds into smaller, less stable fragments. In contrast, some biomolecules, such as proteins excreted by bacteria can form aggregates via cross-linking due to photo-oxidation. To examine whether light-induced aggregation can occur in the marine environment, we conducted irradiation experiments on a well-characterized protein-containing exopolymeric substance (EPS) from the marine bacterium *Sagitulla stellata*. Our results show that after 1 h sunlight irradiation, the turbidity level of soluble EPS was 62 % higher than in the dark control. Flow cytometry also confirmed that more larger sized particles were formed by sunlight. In addition, we determined a higher mass of aggregates collected on filter in the irradiated samples. This suggests light can induce aggregation of this bacterial EPS. The relatively high protein content of the bacterial EPS compared to a non-protein containing EPS from phytoplankton *Amphora sp.*, and the elevated ratio of protein to carbohydrate of the aggregates suggest that photo-oxidation of proteins is responsible for aggregate formation. Reactive oxygen species hydroxyl radical and peroxide played critical roles in the photo-oxidation process, and salt and Ca^{2+} assisted the aggregation process. Light-induced aggregation provides new insights into polymer assembly, marine snow formation, and the fate/transport of organic carbon and nitrogen in the ocean.