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INFLUENCE OF BEAM VELOCITY / INCIDENT ANGLE AT MATERIALS SURFACE OF HYPERTHERMAL AO ON NANO-SCALE SHAPE FORMATION ESTIMATED BY MOLECULAR DYNAMICS

Abstract

Atomic oxygen exists in low Earth orbit (altitudes of 200 to 700 km), where the International Space Station and Earth observation satellites fly. Atomic oxygen (AO) is generated by dissociation of oxygen molecules due to ultraviolet rays from the Sun. Spacecraft in orbit is equipped with heat control materials made of polymeric materials on their surfaces to protect them from space environment such as radiation, ultraviolet rays, and extreme temperature changes, but when AO collides with them at a relative velocity of 8 km/s (equivalent to the flight speed of a satellite), it is known that AO induces oxidation and degradation of polymeric materials. Therefore, there have been various studies on the mechanism of material degradation by AO irradiation. In previous studies, needle-like protrusions of nano- and micrometer-order were observed on the surface of materials irradiated with AO, and high reproducibility of the formed shapes was also confirmed. In this study, we focus on the shape formation and their reproducibility, and investigate the possibility of surface processing technology of polymer materials by AO irradiation. Previous studies on AO irradiation have assumed that AO irradiates polymer materials at the speed of satellite flight and vertically. If AO irradiation is to be used in surface processing technology, it is necessary to understand the influence of AO irradiation conditions on surface shape formation. The presenter's group is working on an analytical approach using molecular dynamics in addition to the experimental approach. Molecular dynamics is an analytical method that models the interaction between atoms with interatomic potential function and solves the motion of atoms based on Newton's equation of motion. In this study, we adopt ReaxFF as the interatomic potential function, which is a reactive force field that can represent the reaction and dissociation of atomic bonds. In this study, we aim to clarify the influence of different irradiation conditions of AO, i.e., different beam velocities and incident angles at materials surface, on the shape formation process of polymer surfaces by using molecular dynamics simulation.