Laser-plasma x-ray source using ceramic target

Naohiro YAMAGUCHI, Yuichiro TAKEMURA, Hiroaki SHOYAMA
and Tamio HARA

Toyota Technological Institute, 2-12-1 Hisakata, Tempaku, Nagoya 468-8511, JAPAN

We are investigating table-top x-ray lasers based on the recombination plasma scheme. In this scheme, the well-known lasing line is Al XI 3d-4f transition line at 15.47 nm. In x-ray laser experiments, pure aluminum slab or tape target is often used. After laser irradiation, some craters are created on the target surface or a part of aluminum tape is ablated, resulting much debris particle production. It causes one of the technical issues for development of practical x-ray lasers and also laser-plasma x-ray sources. On the other hand, ceramic materials containing Al would produce few debris because of its high sublimating decomposition temperature (2450 °C), whereas the melting point of Al metal is 660 °C. Though, ceramic materials could be useful as target materials, there are no attempts for laser-plasma x-ray sources.

We have carried out x-ray laser experiments using aluminum nitride as target material. A sintered AlN plate of 2 mm thickness was irradiated by a train of 16 pulses (100 ps width, 200 ps interval) with power density of about 10^{11}-10^{12} W/cm^2. Incident laser was focused in a line of 11 mm length onto the target. Soft x-ray spectrum originating from Al XI (Li-like Al) ions was measured with the same intensity as in the case of Al slab target, though the concentration of Al is lower than in pure aluminum. Craters on the AlN plate after single laser shot were not clear under optical microscope observation. It was found that when the laser was focused on the same position of the target, the 15.47 nm x-ray intensity for each laser shot was almost constant for 65 shots and more. Whereas in the case of an Al slab target, the x-ray intensity decreased for more than 10 laser shots. It would be possible to construct a long-lived and compact laser-plasma x-ray source with less debris using a peace of AlN plate.

Quantitative results on x-ray radiation, debris and target surface deformation will be presented.