# Interaction of capillary discharged soft-x-ray laser at 46.9nm with $BaF_2$

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**Abstracts:** *$BaF_2$ targets were ablated by a capillary-discharged 46.9nm laser beam focused by a toroidal mirror at grazing incidence. The peak power densities of the focal spot were about $2\times10^7 W/cm^2$ and $1.2\times10^8 W/cm^2$. Clear ablation patterns on the surfaces of $BaF_2$ were observed. In the damage area, the nanostructures induced by the soft-x-ray laser with different power densities were observed to show different features.*

Interaction of soft-x-ray laser with matters plays an important role in material nano-patterning, biologic detection, and surface modification. And capillary discharged soft-x-ray laser is a efficient radiation source to be utilized in these interaction experiments, because of its less expense, easy operation and long service life. Since J. J. Rocca's group reported the ablation of Cu by the laser at 46.9nm in 1999, a bunch of solid targets have been irradiated by x-ray laser in the experiments. Among these materials, dielectrics with a large bandgap ($E_g$) is supposed to be important research objects, since they can be efficient ablated by x-ray laser while be usually transparent to the sources from optical radiation radiation to the vacuum ultraviolet radiation.

The focusing of x-ray laser is a key point in the experiments. Spherical mirrors with a Sc/Si multilayer coating or an Ir coating are always used to focus a 46.9nm laser at normal incidence in the interaction experiments. These mirrors serve to reduce optical aberration and increase the power density of the focused beam. However, their reflectivity for 46.9nm laser is only 15%-40% and they are easily damaged by the laser and the ejection of the capillary discharge plasma. In this report, we describe the interaction of soft-x-ray laser with $BaF_2$ ($E_g$=9.1eV). The laser was focused by a toroidal mirror at glazing incidence with a reflectivity of 90%. And thanks to the aberration induced by the glazing incidence, patterns caused by the lasers of different power densities can be obtained in the same ablation area, which is helpful to study the damage mechanism.

The experiments were operated by capillary discharged 46.9nm x-ray laser generated by 35cm and 45cm-long $Ar^{8+}$ plasma columns with the focused beam spots of a power density of $2\times10^7 W/cm^2$ and $1.2\times10^8 W/cm^2$. And the ablation patterns were detected by atomic force microscope (AFM). The ripple-like nanostrucures and fragmentation-like nanostrucures were found in the ablation area. In the presentation, we will show the details of the nanostructures comparison with different radiation shots and different laser power density. Also the beam path simulation by software ZEMAX will be mentioned.