Silicon Nitride Furnace Installation

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Low-stress silicon nitride windows are used as a component of targets for many high-energy physics experiments. These are thin (50 to 500 nm thick) substrates upon which materials of interest are applied such as metal films or occasionally biological materials. The windows have been used in targets for OMEGA, Jasper, ALS at LBNL and at the Center for Accelerator Mass Spectrometry (CAMS). A window fabricated for CAMS is depicted in Fig. 1.

These windows are fabricated in LLNL's cleanroom facilities. Often, many hundreds of windows are fabricated for a particular target application. A new silicon nitride furnace was installed under this project and is a great improvement over the former system. The former system was a multi-user system in which a variety of materials were processed including carbon. Occasionally, the former system would become contaminated with particulates, possibly from organics, which adversely affected the quality of the silicon nitride films. Further, the former system was very variable in its output, exhibiting very non-uniform films across a wafer and from wafer to wafer. These attributes made producing acceptable films slow, tedious work. The new silicon nitride system will greatly improve the quality of the films processed in this facility.

Project Goals

The goal of this project was to install a new low-stress silicon nitride furnace that would provide uniformly thick nitride films across a set of 25 wafers. The furnace would be used for particular non-organic substrates to maintain cleanliness.

Relevance to LLNL Mission

Several programs at LLNL use targets in accelerator or laser systems to measure material properties such as opacity, to conduct warm dense matter experiments, or to serve as a gas barrier

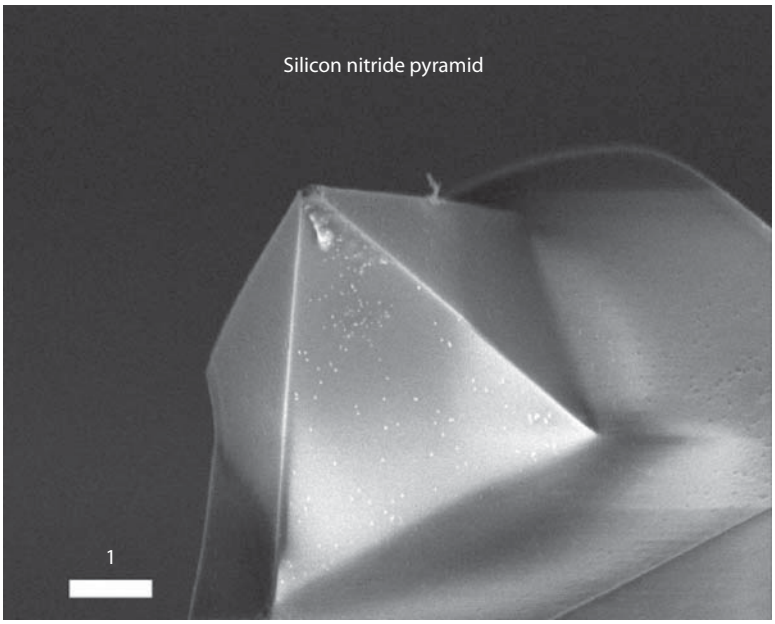

Figure 1. Silicon nitride window fabricated for CAMS.

for the measurements of gas properties. Silicon nitride windows can be an important component of those targets. Silicon nitride windows are also used to produce photocathodes for streak cameras for these experiments.

FY2006 Accomplishments and Results

Low-stress nitride is a non-stoichiometric film produced in a reaction between ammonia and dichlorosilane at about 800 ºC at 300 mTorr. We completed the installation process, which involved tasks such as 1) installing and testing gas lines, manifolds, and gas sensors with special consideration given to the toxic nature of the gas; 2) installing custom thermocouples, interlocks, and brackets; 3) installing a vacuum capability; and 4) installing a controller. The completed system is shown in Fig. 2.

Figure 2. Silicon nitride deposition furnace.