

Cleaning and outgassing studies of machinable tungsten for beamline safety shutters

C. Liu, D. Ryding, R. W. Nielsen, T. L. Kruey, and T. M. Kuzay
Advanced Photon Source, Argonne National Laboratory, Argonne, IL 60439

Machinable tungsten blocks are used as safety shutters in the front ends and the beamlines at the Advanced Photon Source (APS). The tungsten used is characterized as UHV-compatible metal by the vendor and was developed through a joint research effort with the APS. Even so, because of the inherent porosity in the sintered tungsten metal, it may present a vacuum problem and has to be subjected to strict vacuum testing before it is put on the beamlines. We have chosen specially heat-treated machinable tungsten with a density of 18 g/cm^3 for the safety shutters. In-house-developed environmentally friendly vacuum cleaning procedures applied to nontungsten metals were used. In this paper we present the results of thermal outgassing tests for safety shutter machinable tungsten sets. Each set consists of five blocks and has a total area of 4500 cm^2 . A cleaning procedure using alkaline detergent, ultrasonic washes, deionized water rinses, and a 500°C vacuum furnace baking was used before outgassing measurements were made. Outgassing rates 10 hours after initial pump down at room temperature reached $\sim 1.60 \times 10^{-10} \text{ Torr} \cdot \text{l} \cdot \text{s}^{-1} \cdot \text{cm}^{-2}$ for machinable tungsten and $\sim 1.56 \times 10^{-10} \text{ Torr} \cdot \text{l} \cdot \text{s}^{-1} \cdot \text{cm}^{-2}$ for the stainless steel vacuum chamber. The outgassing rate 24 hours after an *in situ* 48-h bake at 160°C is also comparable to that of the stainless steel vacuum chamber. The importance of a 500°C vacuum furnace baking has been confirmed by outgassing studies for machinable tungsten sets that were not subject to vacuum furnace baking.

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