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THE FABRICATION OF HIGH RATE CHROMIUM GETTER SOURCES FOR FUSION APPLICATIONS*

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Design and fabrication techniques are described for the manufacture of large-capacity chromium getter sources, analogous to the commercially available titanium getter source known as "Ti-Ball," manufactured by Varian Associates.[1]

1. INTRODUCTION

Vacuum wall surfaces have a major effect on tokamak plasma characteristics as a source of impurities. Titanium gettering[2] has been shown to be a powerful technique for controlling such impurities. A serious disadvantage of this technique is the large hydrogen or tritium holdup in the gettered layers. An attractive alternative to titanium as a getter material is chromium which does not retain such a high hydrogen inventory. Early experiments have shown that chromium is a successful getter material for hydrogen environments such as in fusion applications.[3]

The finished chromium getter source consists of two thin wall, approximately hemispherical halves, electron beam welded together. The chromium is heated to sublimation temperatures with a helically wound filament located inside the source. The completed assembly is mount compatible with a Varian "Ti-Ball." Several of these chromium getter sources have been built and successfully tested.[3]

2. ASSEMBLY TECHNIQUES

Chromium is a brittle and hard metal that has temperature dependent machining characteristics requiring particular attention to the cooling of work surfaces, tool profiles, and cutting speeds.

The chromium raw material was received from Materials Research Corporation[4] as a refractory metal in "as cast" form and cylindrical in shape. Machining attempts were directed toward fabricating a chromium getter element similar to Varian's "Ti-Ball" titanium getter sources as presently used in the ISX-B tokamak at the Oak Ridge National Laboratory.

The part to be machined was a "stretched" hollow sphere with outside dimensions of about 1-1/2 in. (3.81 cm) in length and 1-1/4 in. (3.18 cm) in diameter with a uniform wall thickness of 0.150 in. (0.038 cm) The nature of the chromium sample required the material to be constantly cooled. "Gulfcut 11-D"[5] lubricant/coolant was found to be well suited to accomplish this and also enabled the material to have a high quality surface finish after machining. A three-jaw chuck on a "14-in." lathe using carbide tipped tools proved the best combination for rough cutting the chromium sample. The large lathe and large size cutting tools were necessary to minimize tool chatter.

After outside rough cutting was complete, contour shaped tools of "Rex-95" tool steel were used for the internal shaping of the semihemispherical halves. It was found that a three-jaw chuck was not suitable for internal machining because the jaws created stress points that cracked the material as the wall

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thickness approached the desired dimension. To avoid this problem, a small diameter cylindrical holding fixture was made that incorporated centering screws to properly align the axis of the part with outside contours. Once centered, Minwax[6] brand quick setting anchoring cement, "Por-Roc," was used to hold the chromium securely for internal machining. The entire inner contour machining was done with properly contour shaped tools with polished relief surfaces. These tools had no back-rake angle and minimum relief angles. Cutting speeds were 60 rpm for rough cutting and 160 rpm finish cutting with feed rates of 0.0015 in. (0.0035 cm) revolution. Constant coolant flow was necessary throughout all machining. Final finish cuts were performed by handfeed.

Fully annealed 0.03 in. (0.076 cm) tungsten wire or 0.04 in.(0.10 cm) tantalum wire was wound on a mandrel and used as the heater element in the "Chro-Ball" (Fig. 1). The wound element was crimped into place inside the

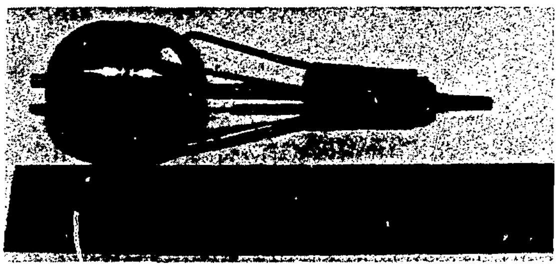

Fig. 1. A completed "Chro-Ball."

chromium halves which were then electron beam welded together. Initial efforts at E-Beam welding produced satisfactory bonding of the chromium halves; however, numerous small stress cracks running perpendicular to the weld were noted on the first weld attempts. A reduced beam energy (12 m Amp at 100 K volt) solved this condition on later "Chro-Ball." The performance of these getter sources is described by Simpkins et al.[3]

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REFERENCES

1. Varian Associates, Palo Alto Vacuum Div., 611 Hansen Way, Palo Alto, CA 94303, USA.

2. A. J. Wootton, P. H. Edmonds, R. C. Isler, P. Mioduszewski, Gettering in ISX-B, J. Nuc. Mat., 111-112 (1982), 479-484.

3. J. E. Simpkins, L. C. Emerson, P. Mioduszewski, A Practical Sublimation Source for Large Scale Chromium Gettering in Fusion Devices, 3rd Topical Meeting on Fusion Materials, Albuquerque, NM, Sept. 19-22, 1983.

4. Materials Research Corp., Orangeburg, N.Y.

5. Gulf Oil Corp., Petroleum Products Div., P.O. Box 2001, Houston, TX 77001.

6. Minwax Construction Products Div., 102 Chestnut Ridge Plaza, Montvale, NJ 07645.