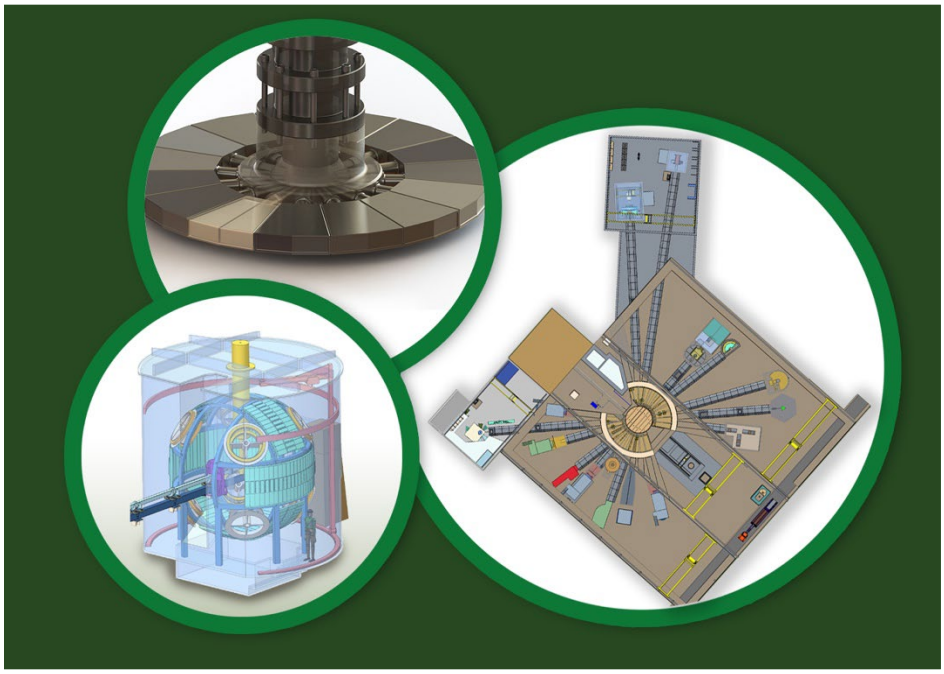
SECOND TARGET STATION (STS) PROJECT

Specification for Vacuum Hot Pressing of Tungsten and Tantalum



Aaron Jacques
Justin Mach
Joel Montross

July 2026

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SPECIFICATION FOR VACUUM HOT PRESSING OF TUNGSTEN AND TANTALUM

Aaron Jacques, Justin Mach, Joel Montross

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Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, TN 37831-6283
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1 REQUIREMENTS FOR VHP BONDING

1.1 SCOPE

The bonding process described in this document outlines the process and steps required to bond a stack up of layered tungsten and tantalum plates.

1.2 SURFACE PREPERATION

Surface preparation on the common bonding faces is to be by a diamond scrub in an ethyl alcohol carrier. A 60 µm ± 15 µm diamond powder blended with an alcohol carrier is applied to the bonding surfaces. A clean leather pad is used as a scrubbing pad to abrade the oxides and other debris from the surfaces. Both the tungsten plates and the tantalum sheet are scrubbed in this fashion. [It is important to avoid aqueous cleaners such that the scrubbed face remains clear of oxides.] At the completion of scrubbing, an alcohol rinse and clean cloth dry leaves the surface in a condition suitable for bonding. The pieces requiring bonding should be assembled in the bonding furnace and inerted within two hours of the completion of scrubbing.

1.3 PROCESS PARAMETERS

1.3.1 Atmosphere

The VHP shall maintain a vacuum level less than $1x10^{-4}$ torr.

1.3.2 Hold Temperature

The parts shall be processed at temperatures of 1200°C ±10°C.

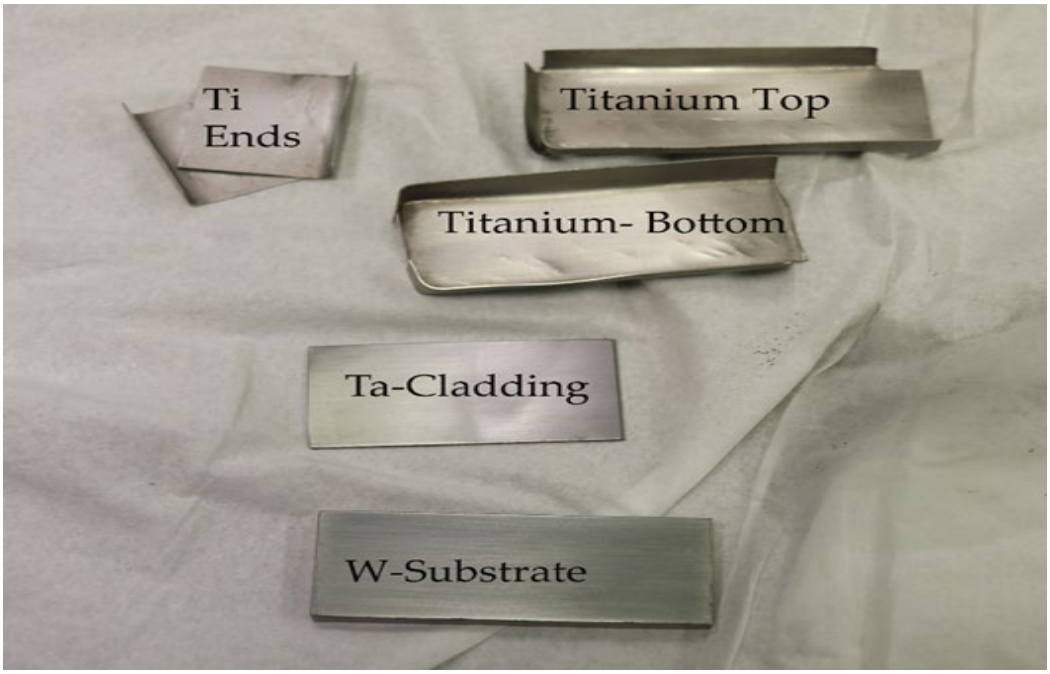
1.3.3 Hold Time

The parts shall be held at the specified temperature and Pressure and environment for a minimum duration of 2.5 hours, but not to exceed 3.5 hours.

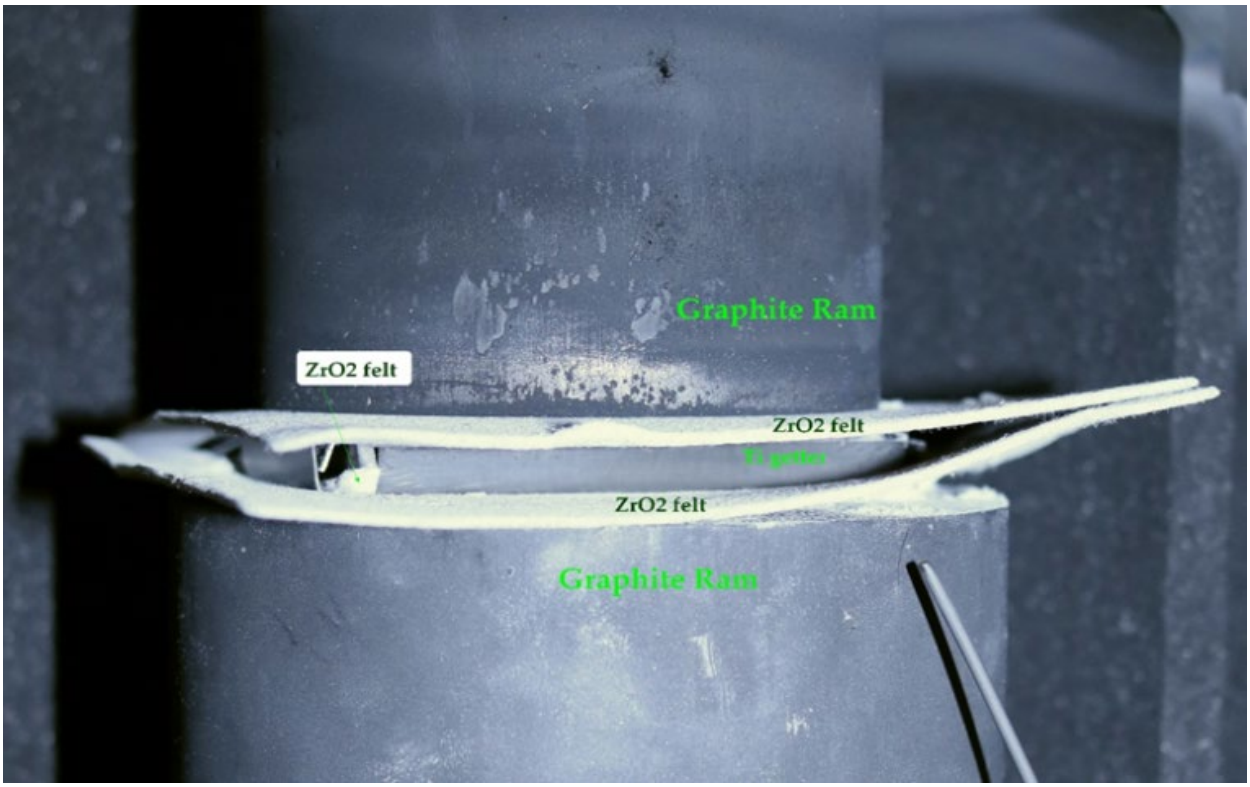
1.3.4 Pressure

The parts shall have an applied pressure of at least 150 MPa.

1.4 OXIDATION PREVENTION



It is important to keep small amounts of oxygen, nitrogen, and water vapor from interfering with the bond. A getter is used to create a restriction in volume that the bond article is exposed to. The recommended getter is titanium foil. A barrier of zirconium oxide ZrO2 felt is recommended between the getter and the graphite ram of the vacuum hot press, and between the getter and the sheets that are being bonded to the tungsten. A typical arrangement for the high temperature (1200 °C) bonding is shown pictorially in the adjacent images. On the bottom graphite platen is a ZrO2 felt. [The felt should be stored at 600 °C in an air furnace to minimize H2O adsorption. The felt should be used directly after removal from the furnace.] On top of the felt, a small tray of Ti foil, slightly larger than the bond article is the beginning of the reduced volume getter. On top of the Ti foil tray, place another layer of ZrO2 felt that nests inside the Ti foil bottom. Place a Ta sheet scrubbed both sides on top of the ZrO2 felt. Place the tile of tungsten (both sides scrubbed) onto the Ta. Place another Ta sheet scrubbed both sides down on top of tungsten. Repeat Ta and Tungsten layers until desired stack-up thickness achieved. Final layer must be Ta. Another layer of ZrO2 felt is placed on top of the tantalum, then the titanium top tray followed by the last layer of the ZrO2 felt. A typical stack is shown in the image below.



1.5 QUALITY REQUIREMENTS

The VHP process shall have at a minimum documentation that shows traceability for:

- Operating parameters for each vessel used in production.
- Software and instrumentation used for control and documentation purposes.
- Vacuum level and leak up rate.
- Contact fixturing within the VHP.
- Fixtures, plates, trays, spacers, hangers, containers, and baskets shall be made of a material compatible with the parts to be treated or shall be adequately isolated to ensure that undesirable reactions, product contamination, and distortions do not occur.