Focus Fusion Eco Safe * Green * Clean * Virtually Unlimited * Cheap

Lawrenceville Plasma Physics, Inc

High technology research, development and consulting in plasma physics, X-ray sources, and Focus Fusion

LPP Focus Fusion Report
October 6, 2015

Summary:

- **Titanium Lining Planned for Vacuum Chamber to Suppress Oxidation**
- **LPPFusion Wants Consultants on Plasma Spectroscopy, Vacuum Coatings**

Titanium Lining for Vacuum Chamber

Based on the results of test shots fired in September, LPPFusion's research team has decided to line the vacuum chamber of the device with titanium or a titanium compound. While we cleaned oxides off the tungsten, these compounds have reappeared due to oxygen in the stainless steel chamber. After some research, we concluded that the oxygen was coming from the break-up of chromium oxide in the stainless steel when it is exposed to the hot plasma. The basic solution to this is to cover up the steel with a material that tightly binds oxygen and that won't give it up even with high heat. Titanium and its compounds are the accepted best material for this purpose.

LPPFusion's team first fired the newly cleaned tungsten electrodes on Sept. 9. This initial shot provides the coating of the insulator that produces a thin current sheath. Such a thin sheath is needed for the pinch that in turn produces fusion reactions. Since this first shot does not have the insulator coating, it never produces fusion. What was not expected was the large amount of oxygen released, as evidenced by an increase in the chamber pressure. In addition, the characteristic yellow-gold color of tungsten bronze (a compound of tungsten, oxygen and hydrogen) also reappeared. It was spread widely on the steel chamber walls and more lightly back on the tungsten electrodes.

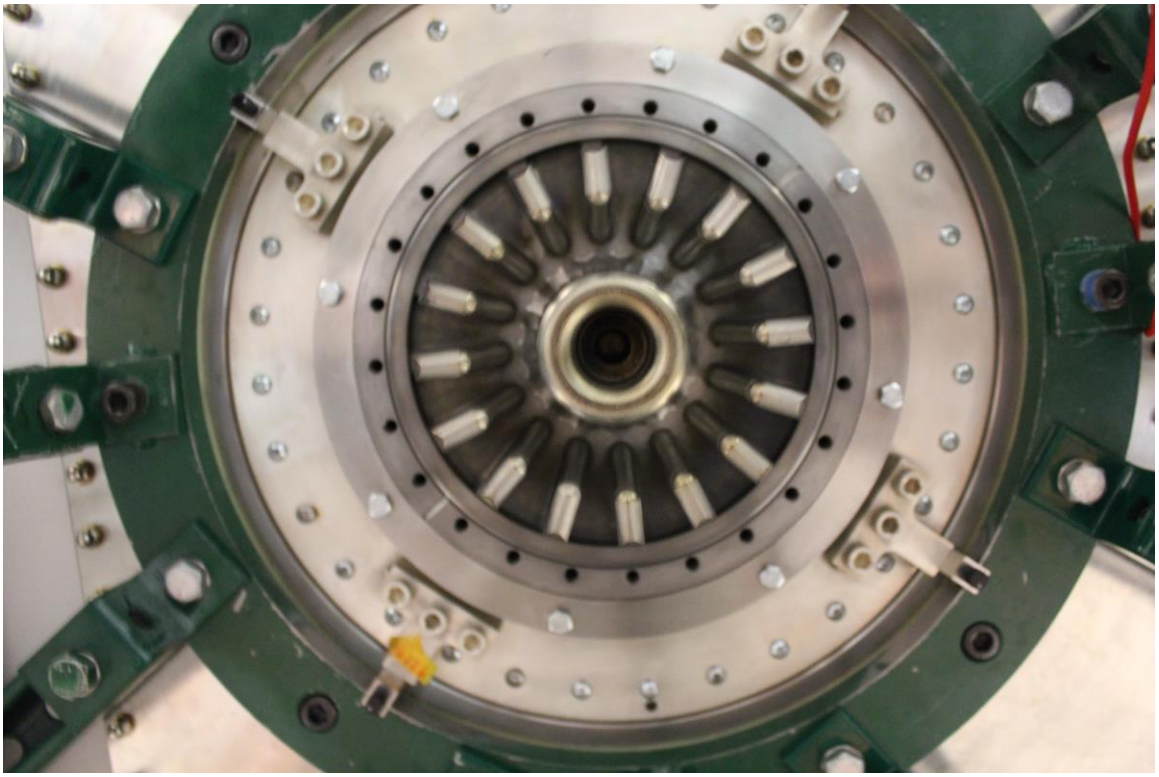
A second cleaning with abrasives of both electrodes and the chamber was not successful. Two more shots fired on Sept. 22 also showed clear evidence of the presence of large amounts of oxygen. We estimated from the extent of the colored oxides that at least 30 mg of oxides were generated for each shot. This is far more than the 30 micrograms we see as an acceptable level of impurities in the plasma.

On Research Physicist Syed Hassan's suggestion, we tried to reduce the oxides by heating the vacuum chamber. However, since the chamber is in contact with the Mylar plastic insulator, it can't be heated to temperatures above 150° C. The lower temperature that we used was not effective.

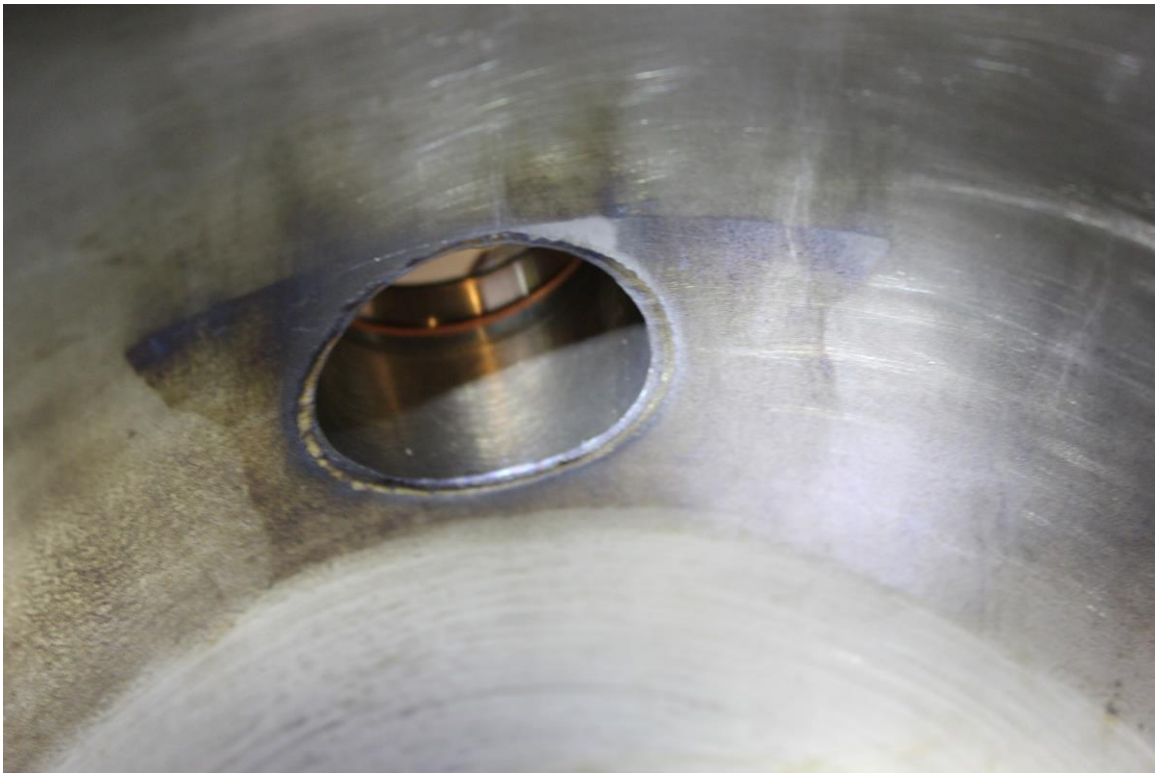
The problem, we concluded, was that during each shot the inner layer of the steel, facing the plasma, was heated by the plasma to about 1000° C, enough to break up the chromium oxide in the stainless steel. Chromium oxide protects steel from further oxidation (rusting) at room temperature, but can't withstand high temperatures, even for the few ms until the heat dissipated through the bulk of the steel.

The solution is to replace the vacuum chambers inner surface with titanium or its compounds. Titanium is well known as an oxygen "getter", a material that grabs and hangs onto oxygen molecules. Since making an entire vacuum chamber from titanium would be costly and time consuming, we plan to line the present steel chamber with titanium. There are two ways of doing this: either brazing titanium sheets to fit inside the chamber, or coating the chamber with a thin titanium or titanium nitride layer. After consultation with suppliers, we decided on the coating, which will be done in the coming weeks. Then we can resume firing with the expectation of greatly reduced oxidation and resulting impurities in plasma.

Oxide deposits (colored material) were still heavy after first shot on Sept. 9.



Oxide deposits were much lighter, but still present after cleaning and two more shots on Sept. 22.



The deposits on the steel chamber were still heavy, providing a reservoir for oxidation. Darker markings are from surface changes due to adhesives in tape applied during an earlier cleaning.

LPPFusion Seeks Consultants on Plasma Spectroscopy and Vacuum Coatings

We are looking for specialists with experience in plasma spectroscopy to help us use our optical spectra to measure impurities in the plasma. We also seek a specialist in vacuum coatings for plasma applications. If you can help, please contact us at Eric@lppfusion.com.