SPARC-RF-15/001
May 27, 2015

THERMAL TESTS ON SPECIAL GASKET FOR ELI S-BAND RF PHOTO INJECTOR

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Abstract

RF photo injectors are able to provide very high currents at low emittances. For future advanced particle accelerators is important to avoid beam instabilities since they easily lengthen the bunch deteriorating their performance . For this purpose, the beam impedance of vacuum components must be kept as low as possible [1].We have developed special copper sealing for high peak power S-band RF photoinjector that is impedance free. We have performed thermal tests on this gasket in order to stress it and to verify vacuum sealing after several thermal bake-out at 180 Celsius degrees. We used copper gasket as the sealing material between copper flanges and finally we succeeded to demonstrate its leak tightness. In this paper, we will report the R&D results.

Introduction

A connection flange, which connects adjacent beam pipes, has an RF impedance due to its transverse step or groove at the connection. The impedance of a flange connection is usually small, but with low energy beams this must be as low as possible. A smooth inner surface as well as a secure electrical contact is highly required at the connection. Normally a connection flange of a beam pipe for various accelerators use a metal gasket that exactly fits the aperture of the beam pipe, bitten between flanges edge design.
Historically this concept of the seal come from the S-band accelerator design at DESY [2], where H. Matsumoto and M. Ohotsuka have successfully realized it for C-band high peak power RF/vacuum system [3].
A special gasket made of copper, thermal annealed, which has a “like- knife” profile (Fig. 1), designed explicitly to vacuum seal RF structure and flat copper flanges ensure has many advantages:
1) the gasket has a knife profile and is bitten at the inner circular flat copper flanges , which makes vacuum leak less sensitive about scratches on the flange’s surface, 2) the seal is gap-less contacting tightly flange/gasket/flange, which produces RF zero impedance 3) the flange has nock-pins for the gasket not to move during assembly and this also helps as a guider for easy assembly, 4) the gasket is disposable and this help in case of trouble or if is necessary to substitute RF gun.

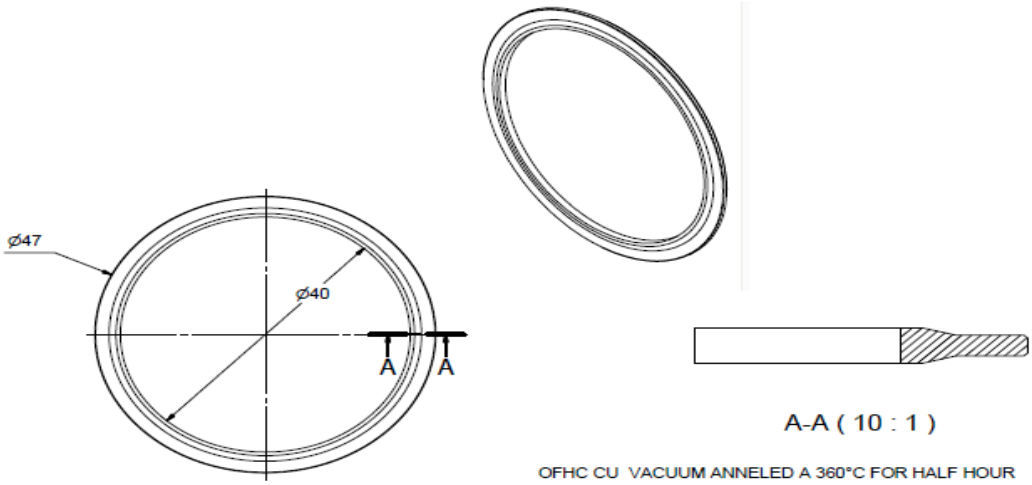

Figure 1: Special gasket design.

In the photoinjector copper structure, shown in Fig. 2, we adopted also other types of gaskets, i.e. helicoflex, that is well known technology, bakeable at 250 Celsius degree and commercial available; it is the vacuum seal and with our particular design it is also RF zero impedance seal between the photoinjector's body and the cathode plate.
This is very useful in case of cathode substitution or if some problem occur.

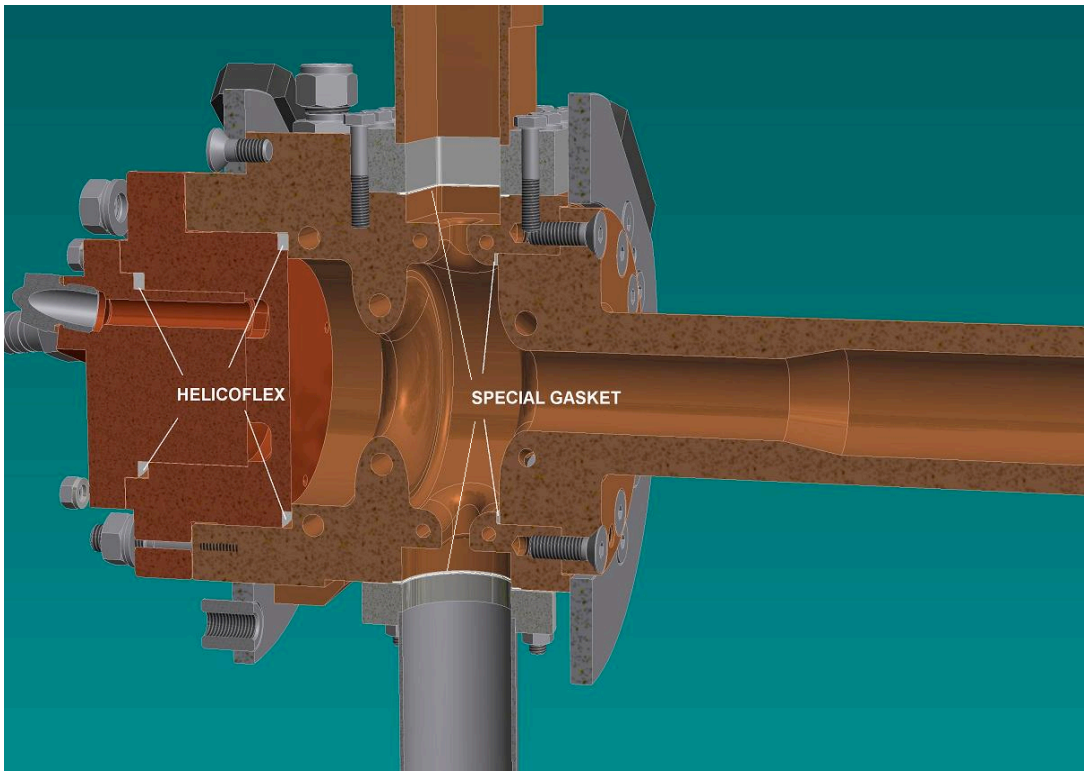

Figure 2: Photoinjector structure.

In order to eliminate air pockets, small holes are made on inside of flanges.

Experimental Method

In order to test gaskets two separate experiments have been performed (Fig 3).

Figure 3: Experimental setup for thermal tests on gaskets.

For the helicoflex case we didn't find particular problems, obviously.
For the special gasket one, after each bake-out cycle at 180 Celsius degree, the joints have been checked by helium leak detector with a sensitivy of $10^{-11}\ \frac{mbar}{liter \cdot \sec}$.
Temperature has been monitored during the experiments, increased at a fix rate until 180 Celsius degrees in 60 minute then kept constant at this level for 40 minute and finally cooled at room temperature by air convection in a couple of hours.
After 6 continuously cycles no leaks have been recognized; also disassembling it no signals of adherence between the gasket and copper flanges have been found, so this design will bring probably an advantage to the vacuum technology of photo injectors, both on performance and cost. Previously other tests have been performed on the same special gasket with rectangular shape, coupling flat stainless-steel/copper flanges with same positive results. RF low power tests will be done and results will be presented in a forthcoming paper.

Conclusions

Special gasket seal is under development for the ELI RF photoinjector gun.
OFHC annealed copper gasket has been tested, bitten between flat flanges made of OFHC forged copper with positive results.
From ours preliminary data this seems a right technology to bring an advantage to the vacuum technology of RF gun. In future, the structures could be realized without brazing

but using this type of special gaskets. A request for a patent is under submission. For the establishment of this technology, R&D is still needed, especially in the field of gasket material.

References

[1] e.g., B. W. Zotterand and S. A. Kheifets, “Impedances and Wakes in High-Energy Particle Accelerators”, World Scientific (1998).
[2] H. Matsumoto et al., EPAC06 proc., pp. 753-755, MOPLS085
[3] H.Matsumoto et al., PAC97, Proc. pp. 530-532.