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Diamond-like Carbon High Temperature Diffusion Barrier For Copper-Gasketed Stainless-Steel Flanges*

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Metal seals used in clamped metallurgical joints show various degrees of diffusion bonding when subjected to elevated temperatures for long periods. This is generally viewed as a "joint failure" because the metal couples cannot be separated after cooling without damage. In a previous Note[1] we presented the results of using reactively sputtered TiN coatings on copper-gasketed UHV flanges as an effective diffusion barrier during high temperature bakeout. However, diffusion along grain boundaries in crystalline TiN may still pose a problem. It is known that amorphous TiN films have superior barrier properties compared to crystalline TiN[2]. We have chosen to assess the qualities of "diamond-like" carbon (hereafter called α-C:H) films for the same purpose.

The appropriateness of α-C:H as a coating lies in that it is amorphous, stable to high temperature (700°C)[3] and relatively inert. The α-C:H films are produced by a radio-frequency technique using CH_4[4]. Film thicknesses of 5 and 15 nm deposited on copper gaskets were used, corresponding to the thickness of TiN used previously[1]. The α–C:H-coated OFHC Cu gaskets were sealed in type 304 stainless steel flanges of 2.75 inch outside diameter made according to the "Conflat"[5] design (Fig. 1). These flanges were torqued to a normal value of 15 ft lbs, evacuated and baked to 550°C at 1 x 10^{-5} torr for up to 200 hours. The assemblies were He-leak tested after bakeout and were found tight to$<2 \times 10^{-10}$ std cc/sec. The flanges easily disengaged without sign of bonding. No sign of carbon diffusion into the Cu was evident under optical microscopic examination.

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5. Registered trademark, Varian Associates, Inc., Palo Alto, CA, U.S.A.

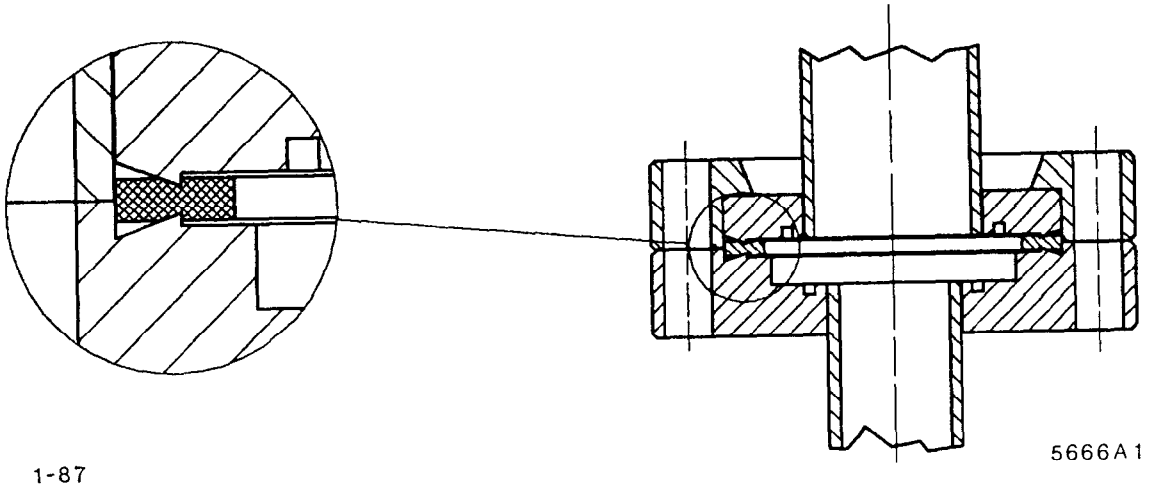

Fig. (1) Cross-section of copper-gasketed Conflat[5] sexless flange seal (2.75 inch outside diameter) showing gasket deformation detail.