FIU Department of Mechanical and Materials Engineering

SENIOR DESIGN PROJECT SYNOPSIS – SPRING 2013

HIGH TEMPERATURE VACUUM SYSTEM

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The main focus of our project is to design, build, and test a high vacuum-temperature furnace for brazing an alumina ceramic feedthorugh to a 99.6% titanium ferrule using gold as the filler metal.

This project is a part of the Boston Retinal Implant Project (BRIP); a joint effort to develop a retinal prosthesis to return some vision of the blind. The BRIP involves developing a retinal implant that would surgically be placed beneath the conjunctiva, where it will electrically stimulate the appropriate ganglion cells via an array of microelectrodes. The implant would receive a wireless signal from a camera mounted on a pair of the glasses and translate these signals to the inner retinal ganglion nerve cells.

Those involved in the BRIP include MIT, the Massachusetts Eye and Ear Infirmary, the VA Boston Healthcare System, the NanoScale Science & Technology Facility at Cornell University, and the Advanced Materials Engineering Research Institute (AMERI) at Florida International University. Under the supervision of Dr. Kinzy Jones, FIU's key role in the project included fabricating and testing the co-fired ceramic process to developing the hermetic packaging containing 200+ feedthourghs used in the retinal implant. During this fabrication, the alumina ceramic feedthorugh must be brazed to a 99.6% titanium ferrule using gold as the filler metal. This process is the main focus of this Senior Design Project.

The final design is composed of a single furnace made of an alumina ceramic tube with 24, stranded, .005" diameter tungsten wire used as the heating element. Two zirconia cylinders carved to fit within each other serves as the insulation for the system. Top and bottom plates were also made of zirconia with the top carved with a 1" opening. The power was monitored and controlled remotely from the computer programming software, Labview. Temperature was also measured, recorded, and trended through a thermo-controller. A linear mechanism was also designed to allow a user to control the vertical movement of the brazing parts as there were moved in and out of the furnace. All systems designed are fully functional in a high vacuum environment.

Under the guidance of Dr. Kinzy Jones, Andriy Durygun, and distinguished graduates in the AMERI labs, this team successfully developed the brazing process as stated above. The temperatures obtained inside the furnace during the brazing process exceed the melting point of the gold to approximately 1280°C. The brazing process took under 20 seconds to complete. The entire process was performed under high vacuum and controlled remotely through two power supplies and a thermo-controller measuring temperature. The titanium-alumina junction was successfully wetted with gold under the alpha-beta phase of the titanium. All techniques used are repeatable with satisfactory results.

The project sheds light on the vacuum process and its challenges; from the design to the temperatures control system. Challenges faced during the project include no convection loads for cooling, using none porous materials, manufacturing, maintaining the integrity of the system, staging the vacuum process correctly, working within the limits of the bell jar, accurately control system design, and properly controlling linear mechanism remotely. The properties of the materials specified for our project presented a number of challenges including performing the brazing process in approximately 15 second during high vacuum.

To address the global learning component, an operations manual in several languages specifying detailing the safety practices and health hazards when operating this furnace. The results are finds would deem useful in several applications that require metal to ceramic joints include, airspace, electronic packaging, sensors, and biomedical.