**Improve the wetting of Gold-ABA filler on micromachined diamond by using nano-metallic layers via vacuum brazing technique**

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**Introduction**

With approximately 200 million people suffering from degenerative retinal conditions, development of vision prostheses, such as the Bionic Eye, are of significant interest in biomedical research. Such medical devices contain sophisticated electronic circuits. Therefore, biocompatible, durable and hermetic packaging is required to protect the electronic circuitry of the implant from the harsh environment inside the human body. Diamond as material exhibits outstanding biochemical stability, chemical inertness and mechanical stability. Because of diamond’s inertness however, generating diamond to diamond joints or metallic feedthroughs in diamond is difficult. This work describes methods to enable the use of Gold-active braze alloys (Au-ABA) to generate low impedance feedthroughs, suitable for data and power transfer to internal electronics (Lichter *et al.* 2015) and features suitable for creating diamond joints. Au-ABA, however, is unable to wet bare diamond surfaces due to their inertness. An additional wetting layer is required. We previously showed (Apollo *et al.* 2016) that silver-ABA can improved wetting of Au braze but only enough for to yield <10% success rate and silver is likely to receive scrutiny by regulators owing to silver’s established toxicity and propensity to degrade, *in vivo*. The principal aim of the present work is to improve the wettability of Au-ABA braze on diamond by applying nano-metallic interlayers.

**Method**

Polycrystalline diamond samples were milled using a variety of laser parameters and different milling patterns, including rectangular holes and lines. Samples were divided into two main categories based on features size namely: small (<1000μm) and large (>1000μm). Prior to brazing, either Molybdenum (Mo), Niobium (Nb) or Mo/Nb bilayer thin films ranging from (10nm-1μm) were sputtered onto the samples. Brazing experiments was performed in a vacuum furnace at 1100 ᵒC for 30 minutes at least 10-5 Torr. Surface and cross-sectional microstructure of braze-diamond interfaces were observed by optical microscopy, scanning electron microscopy and Energy-dispersive X-ray spectroscopy.

**Results and discussion**

Modification of the diamond surface with adhesion-promoting layers of Nb and Mo significantly improved the wetting of Au-ABA. The metallic adhesion layers function as a chemical bridge that facilitated the spreading and wetting of Au-ABA on diamond. Titanium (Ti), contained in the Au-ABA, migrates through this layer into the diamond surface and form titanium Carbide (TiC). Mo single layers showed better Au spreading than Nb single layers and wetting increased with increasing thickness of the metallic layers. For smaller features, bilayers of Mo/Nb showed the best performance in terms filling of laser milled features in diamond. Wetting and filling of small features was optimal when layers of 1μm Mo/1μm Nb were used. For larger features, however, Mo/Nb bilayer (1/1μm) acted as a diffusion barrier for migration of Ti to the diamond surface resulted in poor bonding. Cracks and weak bonding were also observed for these samples for Nb and Mo/Nb layers. This was likely due to the mismatch of CTE between component, formation of more continuous carbide (TiC) layer (compare to small areas) and intermetallic compounds in the diamond/Au interface. Wetting and bonding in larger features was optimal when single Mo wetting layers were employed.

**References**

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