Seamless Ceramics for Biomedical Applications

Tech ID: 32364 / UC Case 2015-938-0

BACKGROUND

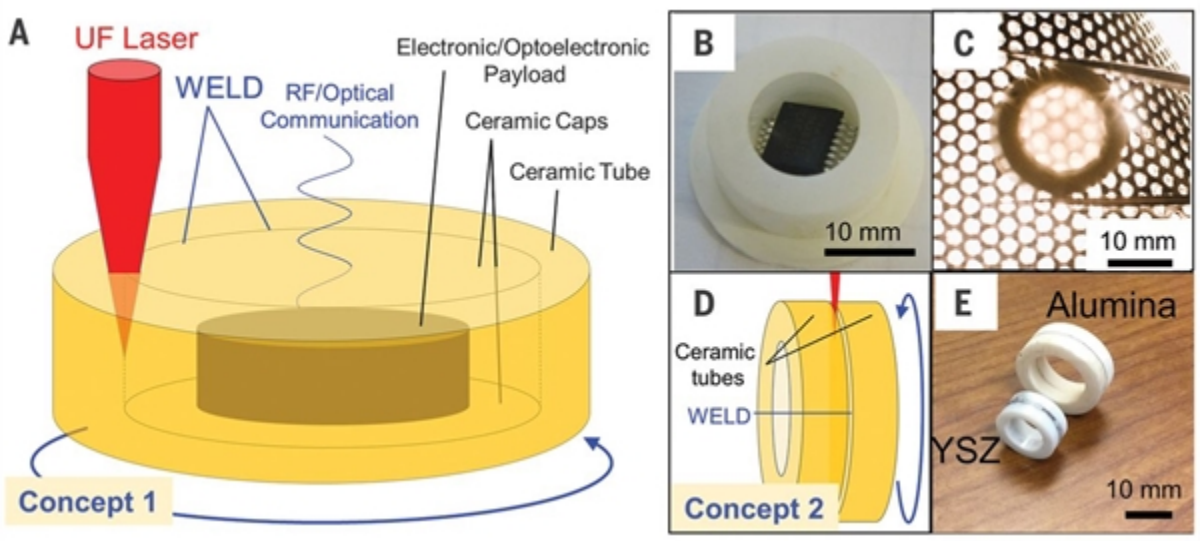
A basic requirement for implantable biomedical devices is long-term compatibility of the packaging materials and leakproof, hermetic seals. Current implant devices are based on sealing dissimilar materials (for example, ceramic-metal using materials with inferior biocompatibility and mechanical strength. There is a need to create seamless ceramic packages for encapsulating enclosed electronics that are biocompatible.

State-of-the-art ceramic joining involves high temperature diffusion bonding. However, reliable diffusion bonding processes only exist for a limited number of ceramic materials and are available for high-cost components. Attempts to weld ceramics using powerful, continuous wave (CW) lasers without high temperature preheating have been unsuccessful because of macroscopic cracking attributed to thermal shock.

BRIEF DESCRIPTION

Prof. Guillermo Aguilar-Mendoza and his research team including colleagues from the University of California campuses in Riverside and San Diego have developed an all ceramic, biocompatible, hermetically sealed package for encapsulating electronics. This technology uses disparate transparent polycrystalline ceramics and is sealed by ultrafast lasers. The laser directly joins the disparate surfaces, protecting the electronic device from damage while ensuring a high-quality seal. The inventors strategically considered both the optical properties of the polycrystalline ceramics (linear and non-linear absorption - NLA) and the laser parameters (exposure time, number of laser pulses and pulse duration - femto second versus pico second). Two different concepts have been identified:

Transparent ceramics for hermetic encapsulation; and,
Diffuse ceramics to demonstrate joining of simple geometries.



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OTHER INFORMATION

KEYWORDS

laser sealing, transparent, polycrystalline, implant

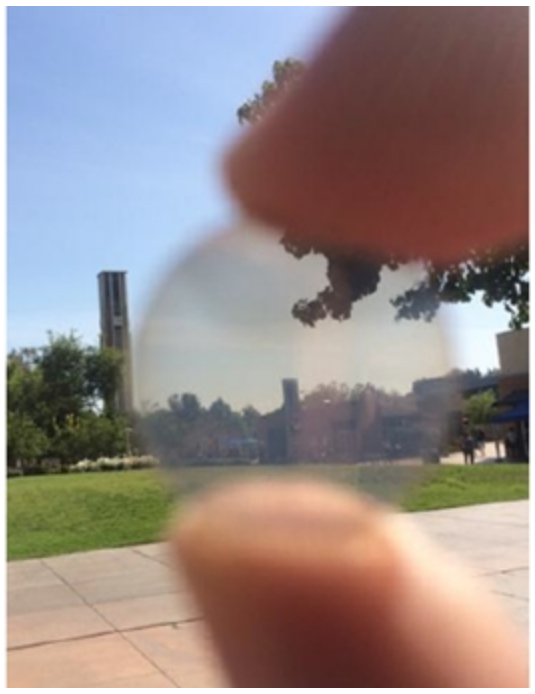
CATEGORIZED AS

- Materials & Chemicals
  - Ceramics
- Medical
  - Devices

RELATED CASES

2015-938-0

In the above image - (a) is a schematic illustration of concept 1 above; (b) picture of a sample electronic payload (an integrated chip) placed inside a ceramic tube; (c) picture of successfully welded assembly of concept 1 - the background pattern (pitch 3.5 mm is visible through a transparent ceramic cap; (d) schematic of concept 2 for welding simple ceramic geometries; and, (e) picture of a successfully welded assembly of Alumina and Ytria-stabilized Zirconia (YSZ).



Picture of transparent ceramics fabricated at UCR.

ADVANTAGES

- The method is versatile for a wide variety of ceramic materials and for a diversity of device geometries.
- Vacuum testing of the assemblies showed the ability to hold a high vacuum with a leak rate that is one order of magnitude better than the requirement for hermetic seals. The assembly satisfies the modern specifications and standards for bio-implantable electronics, military, and space applications.
- Compared to traditional diffusion bonding which uses 1000-Watt high temperature furnaces, the current technology uses an ultrafast laser of 50 Watts (maximum power) and consumes on the order of 25 Watt-hour.

APPLICATIONS

- For use as a packaging material for biomedical implants like pacemakers and for future medical technologies like optogenetics.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Published Application	20220281774	09/08/2022	2015-938

RELATED MATERIALS

- E.H. Penilla, et al., “Ultrafast laser welding of ceramics”, Science, 365, pp. 803–808, 2019 - 08/23/2019
- Biocompatibility and thermal profile of transparent nanocrystalline yttria-stabilized-zirconia calvarium prosthesis.

OTHER INFORMATION

- Please see press coverage on the Window to the Brain implant which provided the inspiration for the laser joining of transparent ceramics.
- Please visit the Center for the Synthesis of Advanced Materials for Biomedical Applications (C-SAMBA) at UCR.
- Please review other medical device inventions by Prof. Aguilar and his team at UCR.

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