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Research paper

Analysis of laser fabricated microjoint performance in cerebrospinal fluid using a computational approach

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ABSTRACT

Assessment of neural biocompatibility requires that materials be tested with exposure in neural fluids. We have studied the mechanical performance of laser bonded microjoints between titanium foil and polyimide film (TiPI) in artificial cerebrospinal fluid (CSF). The samples were exposed in CSF for two, four and twelve weeks at 37 °C. The laser microbonds showed initial degradation up to four weeks which then stabilized afterwards and retained similar strength until twelve weeks. To understand this bond degradation mechanism better, a finite element modeling approach was adopted. From the finite element results, it was revealed that bond degradation was not due to the hygroscopic expansion of polyimide. Rather, relaxation of the process induced residual stresses may have resulted in weakening of the bond strength as observed from experimental measurements.

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1. Introduction

Neural implant devices involve various proven biocompatible materials such as metals (e.g. titanium), non-metals (silicon, glass) and polymers (e.g. polyimide) (Cameron et al., 1998; Fulzele et al., 2003; Malmstrom et al., 1998; Prigent et al., 1998; Quester et al., 2003; Scribner et al., 2003; Selvakumaran et al., 2002). For encapsulating the implant devices, some of these materials must be hermetically joined in similar or dissimilar combinations. Microjoining and hermetic sealing of these dissimilar materials can be achieved by localized laser joining. It is mentioned here that the proven methods for adhesive-free (and hence biocompatible) localized joining and hermetic sealing of non-metals and dissimilar material combinations in particular,

do not yet exist for implantable microsystems. It is expected that localized laser joining will meet these requirements for biomedical implant encapsulation. Recently, we have employed transmission type laser-joining procedure (Fig. 1) to join several biocompatible material combinations, such as titanium/polyimide (Bauer et al., 2004; Georgiev et al., 2004; Mahmood et al., 2007; Mian et al., 2005), and titanium coated glass/polyimide systems (Mian et al., 2007; Newaz et al., 2006). Transmission Laser Bonding is a technique that permits localized bonding of dissimilar materials using a focused laser. One of the materials must be sufficiently transparent to the wavelength of the laser to allow transmission of a significant portion of the beam to reach the material interface, while the second material must be sufficiently opaque to that wavelength to allow absorption of the incident

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