World Academy of Science, Engineering and Technology
International Journal of Biomedical and Biological Engineering
Vol:8, No:07, 2014

Preparation and Sealing of Polymer Microchannels Using EB Lithography and Laser Welding

Authors : Ian Jones, Jonathan Griffiths

Abstract : Laser welding offers the potential for making very precise joints in plastics products, both in terms of the joint location and the amount of heating applied. These methods have allowed the production of complex products such as microfluidic devices where channels and structure resolution below 100 µm is regularly used. However, to date, the dimension of welds made using lasers has been limited by the focus spot size that is achievable from the laser source. Theoretically, the minimum spot size possible from a laser is comparable to the wavelength of the radiation emitted. Practically, with reasonable focal length optics the spot size achievable is a few factors larger than this, and the melt zone in a plastics weld is larger again than this. The narrowest welds feasible to date have therefore been 10-20 µm wide using a near-infrared laser source. The aim of this work was to prepare laser absorber tracks and channels less than 10 µm wide in PMMA thermoplastic using EB lithography followed by sealing of channels using laser welding to carry out welds with widths of the order of 1 µm, below the resolution limit of the near-infrared laser used. Welded joints with a width of 1 µm have been achieved as well as channels with a width of 5 µm. The procedure was based on the principle of transmission laser welding using a thin coating of infrared absorbent material at the joint interface. The coating was patterned using electron-beam lithography to obtain the required resolution in a reproducible manner and that resolution was retained after the transmission laser welding process. The joint strength was ratified using larger scale samples. The results demonstrate that plastics products could be made with a high density of structure with resolution below 1 um, and that welding can be applied without excessively heating regions beyond the weld lines. This may be applied to smaller scale sensor and analysis chips, micro-bio and chemical reactors and to microelectronic packaging.

Keywords : microchannels, polymer, EB lithography, laser welding
Conference Title : ICMN 2014 : International Conference on Microfluidics and Nanofluidics
Conference Location : Prague, Czechia
Conference Dates : July 10-11, 2014