Vacuum Sealing Technologies for Microchemical Reactors
K. Cheung, K.F. Jensen, M.A. Schmidt
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Current portable power sources may soon fail to meet the increasing demand for larger and larger power densities. To address this concern, our group has been developing MEMS power generation schemes that are focused around fuel cells and thermophotovoltaics. At the core of these systems is a suspended tube microreactor that has been designed to process chemical fuels [1]. Proper thermal management is critical for high reactor efficiency, but substantial heat loss is attributed to conduction and convection through air, as shown in Figure 1. A straightforward solution is to eliminate the heat loss pathways associated with air by utilizing a vacuum package. We are exploring a glass frit bonding method for vacuum sealing.

The leading cause of failure for a glass frit hermetic seal is large voids that are formed in the frit while bonding [2]. Progress has been made toward the optimization of presintering and bonding parameters to reduce or eliminate void formation. A vacuum package of 150 mTorr was obtained after optimization, but became leaky shortly after. An alternate packaging method using a two-step bond process, inspired by [3], was devised and developed. Recent experiments of the process, depicted in Figure 2, show that the initial box bond is capable of producing a hermetic seal. Enhancements through the incorporation of non-evaporable getters will be assessed once a vacuum package is achieved.

Figure 1: Experimental data for the heat loss of a suspended tube microreactor as a function of temperature in atmosphere (red) and in vacuum (green), plotted with the heat loss components through air, radiation, and solid conduction (blue, black, and orange respectively) [1]

Figure 2: Basic concept of the two-step approach (a) initial bond in box furnace (blue = frit, black = silicon, yellow = metallization) (b) place solder/frit (orange) into pump-out hole, and (c) final seal-off

REFERENCES: