Academic Journal of Science and Technology
ISSN: 2771-3032 | Vol. 5, No. 2, 2023

Design of a Thermopressed Bonding Vacuum Box for Microfluidic Chips

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Abstract: In this paper, a vacuum chamber is designed to facilitate the hot pressing bonding of microfluidic chips, according to the current microfluidic chip hot pressing bonding process, chip deformation, flow channel edge bubbles and other problems, Hot-pressed bonding in a vacuum device is proposed to hot-press the chip, combined with the structure of the heat press, the structure of the vacuum box, the connection line, etc. were designed, use solidworks3D modeling, the design, production, assembly and experiment of the vacuum hot pressing device were completed.

Keywords: Microfluidic chips, Hot press bonding, Vacuum structure.

1. Introduction

Microfluidic chips have the advantages of small size, low cost, easy to carry, small environmental pollution, automatic analysis process, fast analysis speed, and few samples and reagents required [1,2]. It has broad application prospects in the fields of genetic detection, in vitro diagnosis, cell sorting, drug synthesis and screening. Samples and reagents are typically reactive in microliters or even nanoliters, in addition to ensuring high accuracy and high efficiency of detection, maximum savings in sample and reagent volume [3]. The bond synthesis between the microfluidic chip structure sheet and the cover sheet is an important key process in the chip manufacturing process. Due to the use of hot-pressed PMMA chip substrate, simple requirements with equipment, low material cost, short process cycle, high forming accuracy, it is suitable for industrialization and other advantages, and hot pressing method is a technology that rapidly replicates microfluidic chips [4]. Therefore, hot pressing bonds and bonding methods have always been a popular bonding method among all bonding methods. However, during the hot press bonding process, there are still some problems. For example, the chip will be misaligned during the hot pressing process, and the edge between the hot pressing process and the chip will not be pressed. The quality after chip bonding will directly affect the detection effect. And reduce the production of genuine rate and production efficiency, increased production costs. To address these issues, in this paper, a vacuum hot pressing device is designed that is conducive to chip hot pressing.

2. Microfluidic Chip Hot Pressing Bonding Vacuum Box Design

Figure 1 Vacuum heat press machine is a heat press machine installed with vacuum box, figure 2 is the structural diagram of the vacuum box. The vacuum box is mainly composed of upper cover, vacuum box, vacuum door, buckle and other structures. The whole structure is made of stainless steel, the vacuum glass in the central observation area is made of quartz glass. There are three important holes in the vacuum box, evacuation holes and two cooling holes, the vacuum hole is connected to the vacuum pump by the air pipe, achieve a vacuum environment, the cooling water circulation system is connected to the hot stage through the cooling hole, enables the hot stage to be cooled quickly to the required temperature, one connection to the hot stage, a connected lower hot stage, the evacuation hole is located on the back wall of the chamber, the cooling holes are located on both sides of the vacuum chamber, here, the cavity is sealed by means of square screws and sealing rings. There are two through holes on the back of the cavity, the outer wire is installed on the heating table through the through the wire hole to realize the heating of the hot stage. The through hole is plugged with cylindrical rubber, the wire is fixed in the center of the rubber to achieve the sealing here, the upper wall of the vacuum box is installed on the hot stage, there is a central hole on the underside of the cavity, the cylinder shaft is connected to the downstage in the chamber through the central hole, on the front side of the cavity is a vacuum door, there is a sealing ring in the inner test of the door, the chamber is sealed when snapped with a snap.

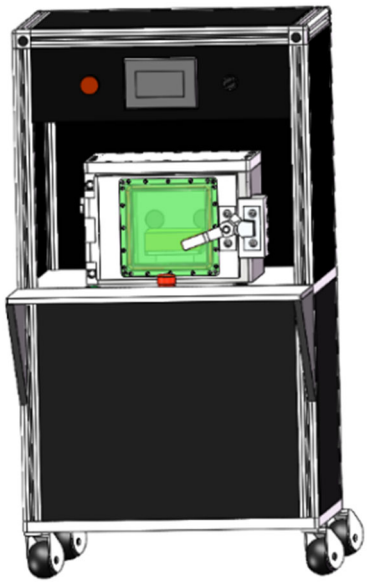
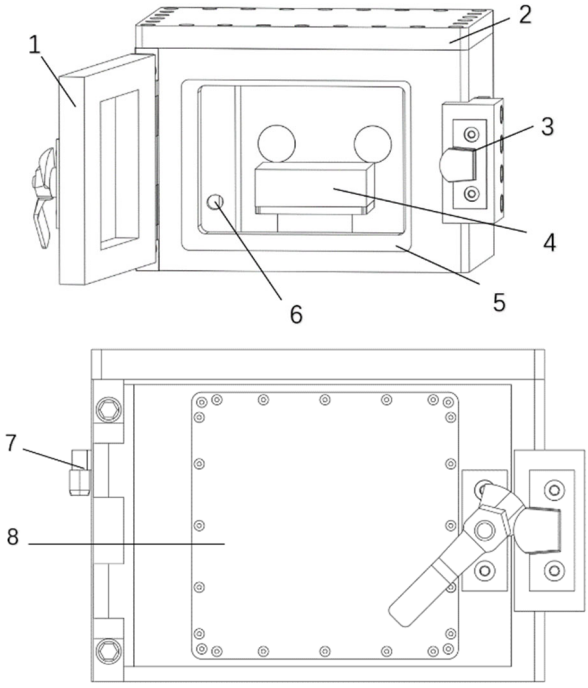


Figure 1. Vacuum heat press



1- Vacuum doors; 2- Top cover; 3- Snap; 4- Autoclave; 5- Seal ring groove; 6 Vacuum holes; 7- Cooling holes; 8- Quartz glass

Figure 2. Vacuum box structure diagram

3. How Vacuum Chambers Work

According to the two-dimensional drawings, some non-standard parts are processed through the processing plant, acquisition of required standard parts and preparation of existing parts and machines, assemble these parts, assembly completed, turn on the air pump, check the cavity for air leakage, after the inspection, complete the assembly, figure 3 shows the vacuum box installed in the vacuum heat press.

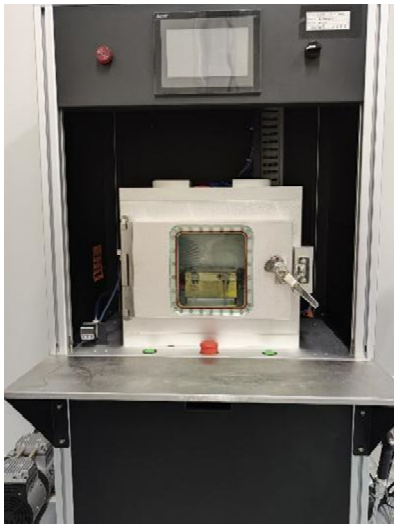


Figure 3. Vacuum heat press machine vacuum box

Turn on the heat press machine first when using, adjust the parameters such as pressure, temperature and initial position required by the heat press, reset the hot pressure table, switch the hot pressing mode as needed, turn on the vacuum pump, turn the vacuum on or off on the display, the autoclave reaches the temperature, place the microfluidic chip structure sheet and cover sheet on the hot pressing table, close the vacuum chamber door, seal the vacuum door with snap-in, turn on the vacuum, start hot pressing.

4. Vacuum Chamber Application Experiment

Take two PMMA cover sheets for verification, take the before and after comparison of not opening the vacuum and opening the vacuum, observe whether the hot pressing effect in the vacuum environment is better than the hot pressing effect without the vacuum open.

Take two PMMA cover sheets from the clean room, do 2 sets of experiments, the first group only turns on the heat press, no vacuum, hot pressing according to the conditions of hot pressing, the results are shown in Figure 3. The second group of open heat presses, open vacuum, hot pressing according to the conditions of hot pressing, the results are shown in Figure 4.

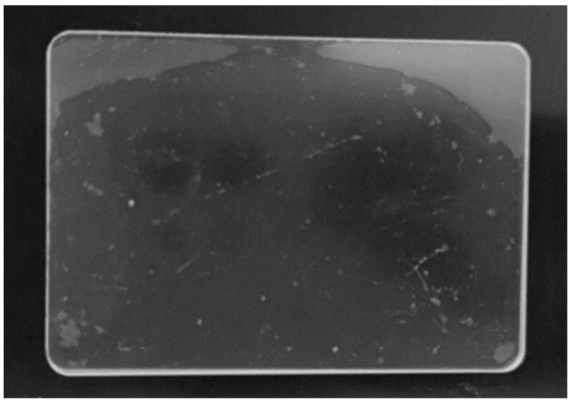


Figure 4. The vacuum is not turned on

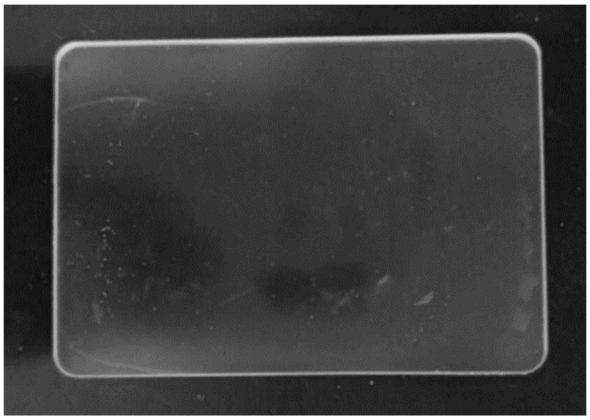


Figure 5. Turn on the vacuum

Based on the results of figures 4 and 5, figure 4 hot pressing without open vacuum, there is a clear unpressed phenomenon between the edges of the two cover sheets, produces large air bubbles. Figure 5 Open vacuum for hot pressing, the two cover sheets do not produce air bubbles, and very homogeneous, the obvious effect is better than the unopened vacuum.

Before hot press bonding, turn on the vacuum, first, the structural sheet and the cover sheet are adsorbed together, prevent during the hot pressing process, when the structural sheet and cover sheet are misaligned, bubbles are generated, or are not compacted, etc. Hot pressing is performed. This design can solve these problems, in the process of hot pressing bonding of microfluidic chips, greatly improve production efficiency and accuracy, reduce production costs.

References

[1] Jacobson S C,Hergenronder R,Koutny L B,et al.High-speed seParations on a microchip [J]. Anal. Chem. 1994, (66): 1114-1118.

[2] FANG Zhaolun. Microfluidic analysis chip [M]. Beijing, Science Press. 2002,(1).

[3] Wu Linghai. Research on vacuum hot pressing bonding system of polymer microfluidic chip[D]. Guangzhou:Guangdong University of Technology,2018.

[4] YE Jiaming, LI Mingjia, ZHOU Yongliang. Rapid production of microfluidic chip mold by hot pressing method[J].China Mechanical Engineering, 2007,(19):2379-2382.)