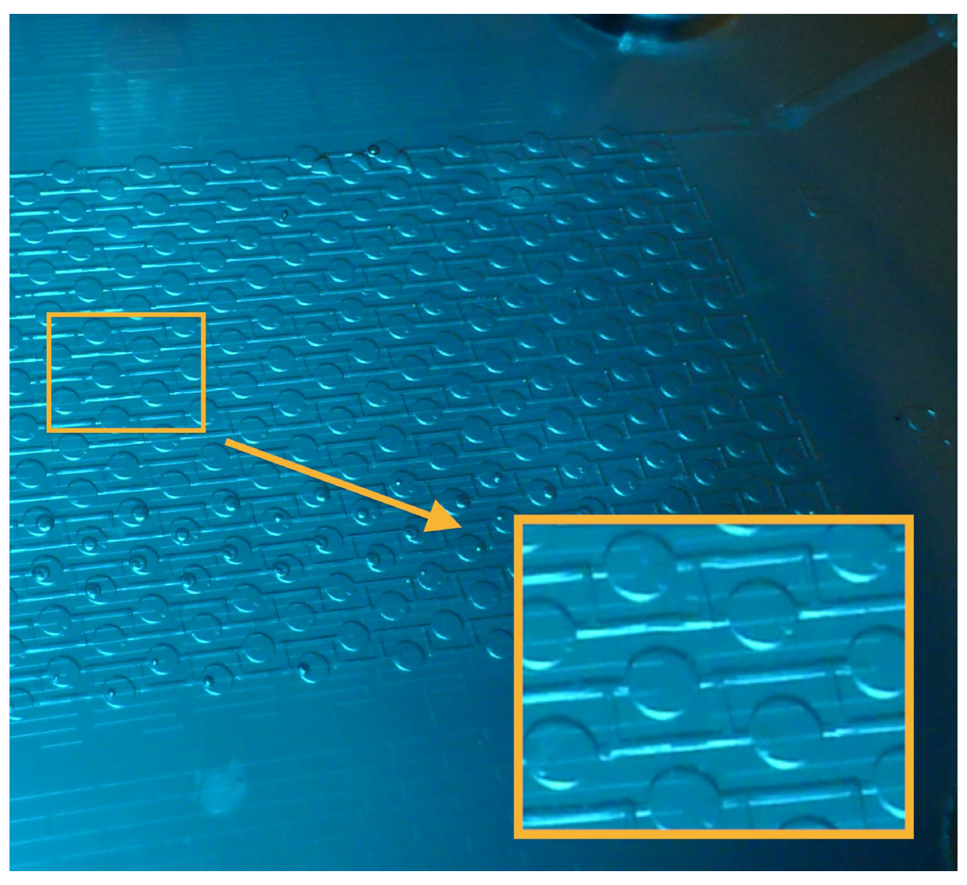
RAPID FABRICATION OF MICROFLUIDIC FOIL CHIPS

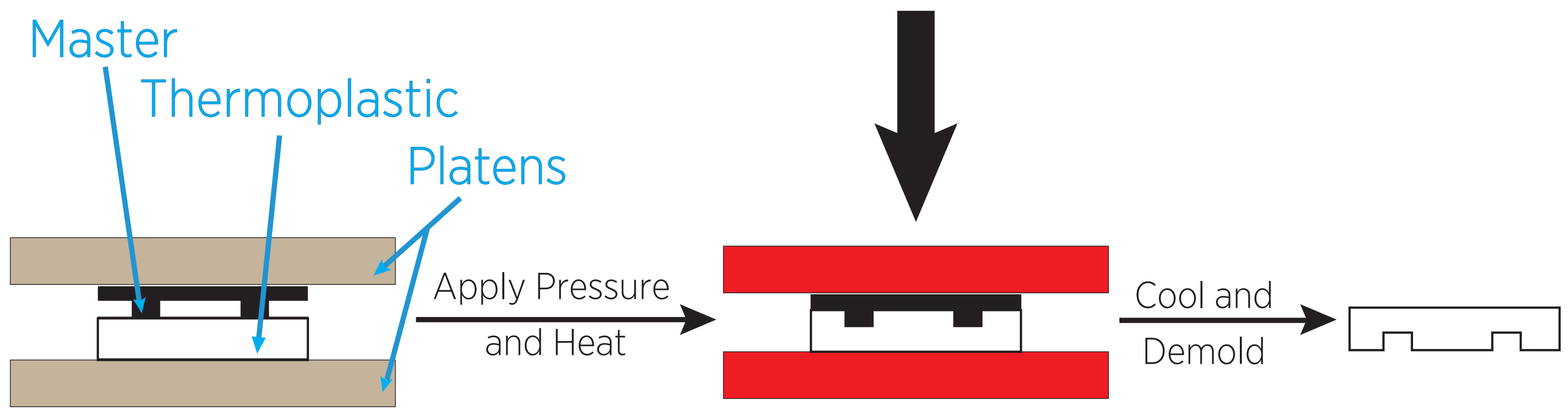
SCOPE Brandeis MRSEC 2013-2014

MICROFLUIDICS

Microfluidics is a rapidly emerging field that utilizes capillary forces at the micro-scale to control fluids. Its applications range from blood diagnostics to protein crystallization. Despite the increasing popularity of the field, the time and cost to manufacture devices have limited its advancement.



HOT EMBOSSING



Hot embossing involves heating the substrate past its glass transition temperature and applying pressure to transfer features from the master to the substrate. The embossed chip is removed after cooling and demolding.

PROJECT DESCRIPTION

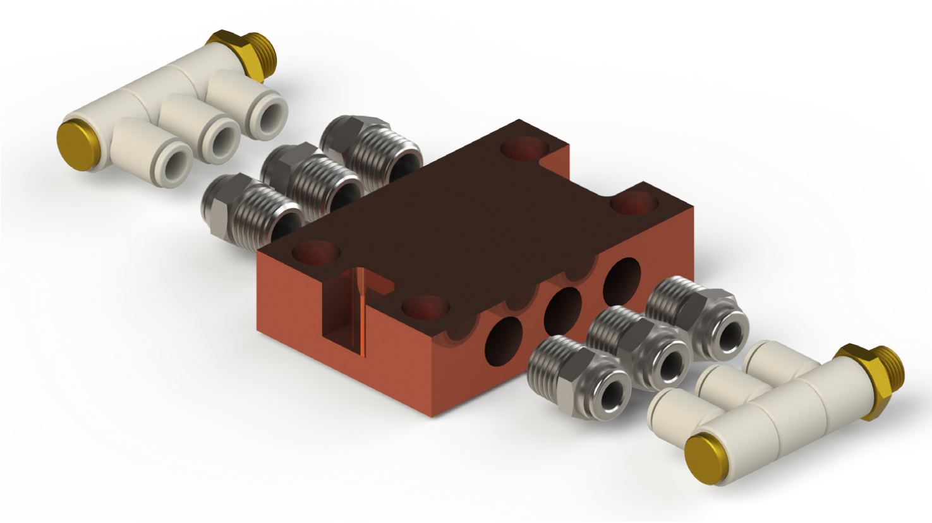
The goal of this project was to develop processes for inexpensive, rapid fabrication of thermoplastic microfluidic devices that can be used in a variety of chemical and biological applications. The Fraden lab at Brandeis MRSEC created a prototype of a thermal linear press that can produce cyclic olefin co-polymer (COC) chips; however, the process had not been optimized to perform at the desired speed and accuracy. The team optimized this linear press to hot emboss 10 μm wide by 10 μm tall channels in COC.

LINEAR PRESS DESIGN

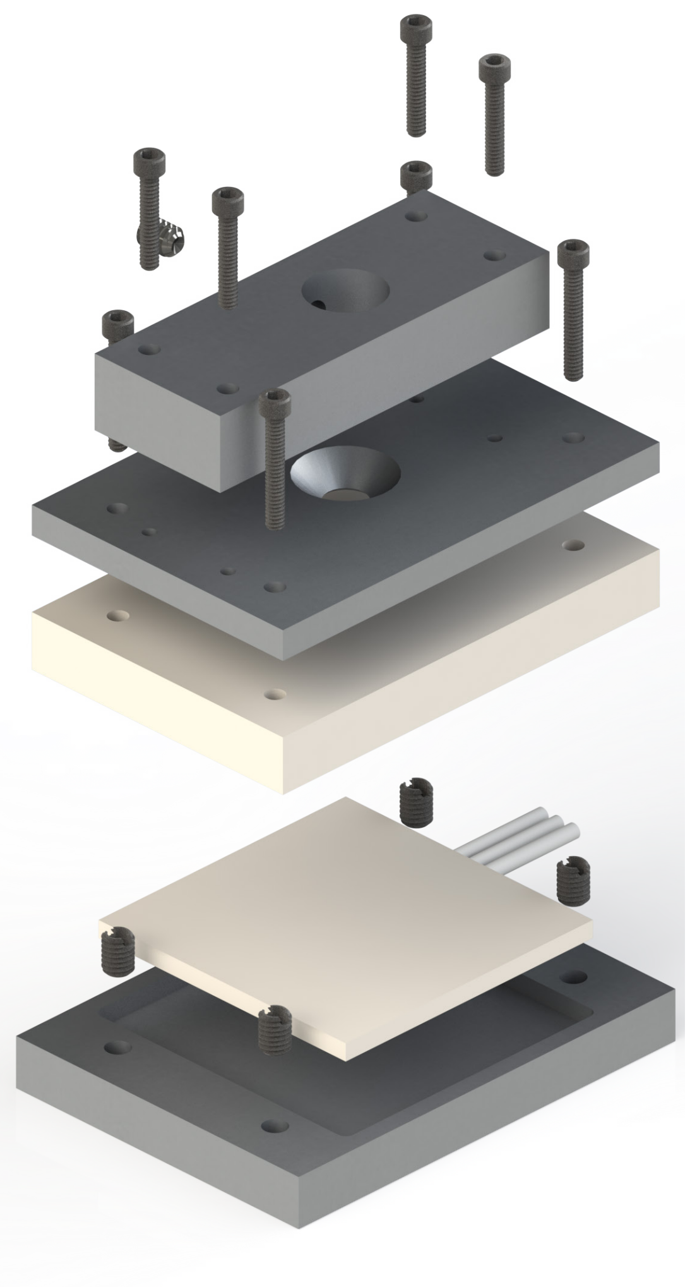
The **linear press** utilizes the hot embossing method to transfer features from the master to the desired substrate. The master and the substrate are placed between the platens, which apply pressure and heat to the system.

The **voltage-controlled regulator** linearly converts voltage to pressure in the cylinder and allows for adjustable load which can be used for embossing with different temperature-pressure profiles.

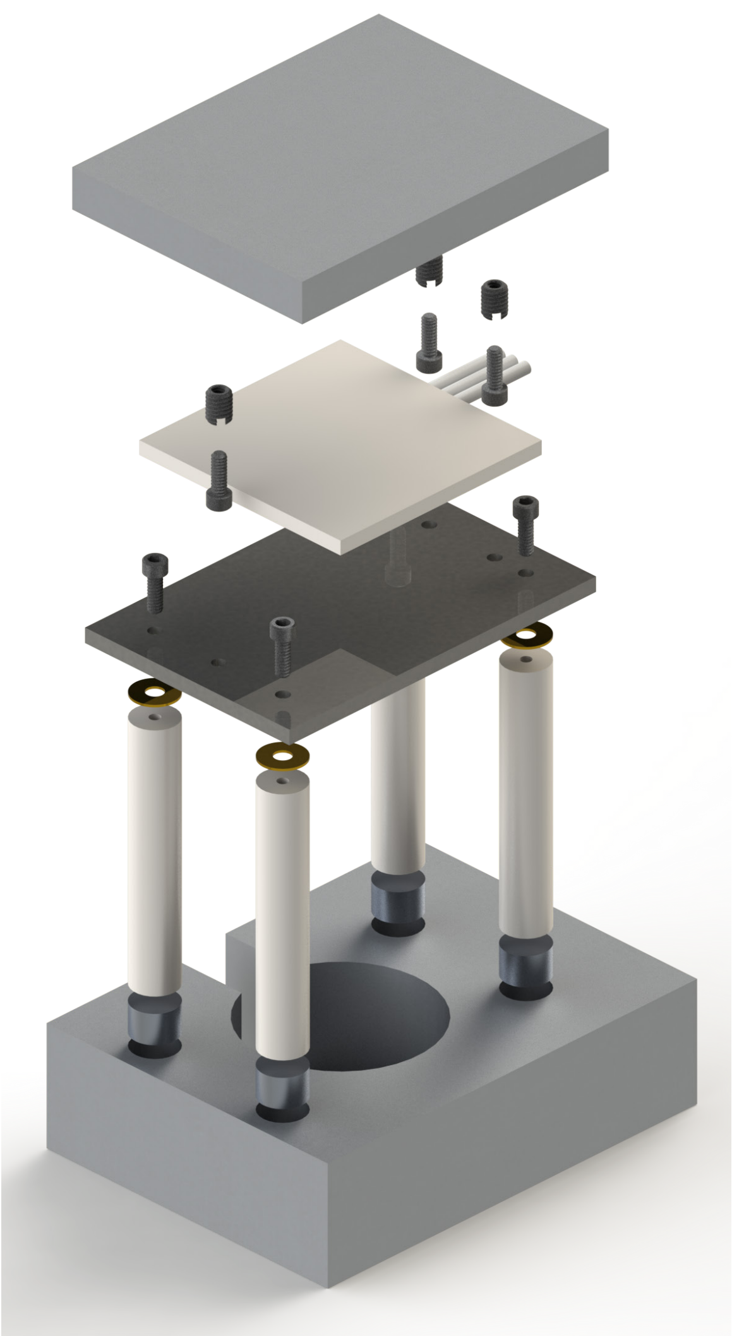
To further minimize the embossing cycle time a water-cooled, **actuated heat sink** was added to the bottom platen. This copper heat sink is engaged through a separate pneumatic cylinder.



Actuated Heat Sink



Top Platen

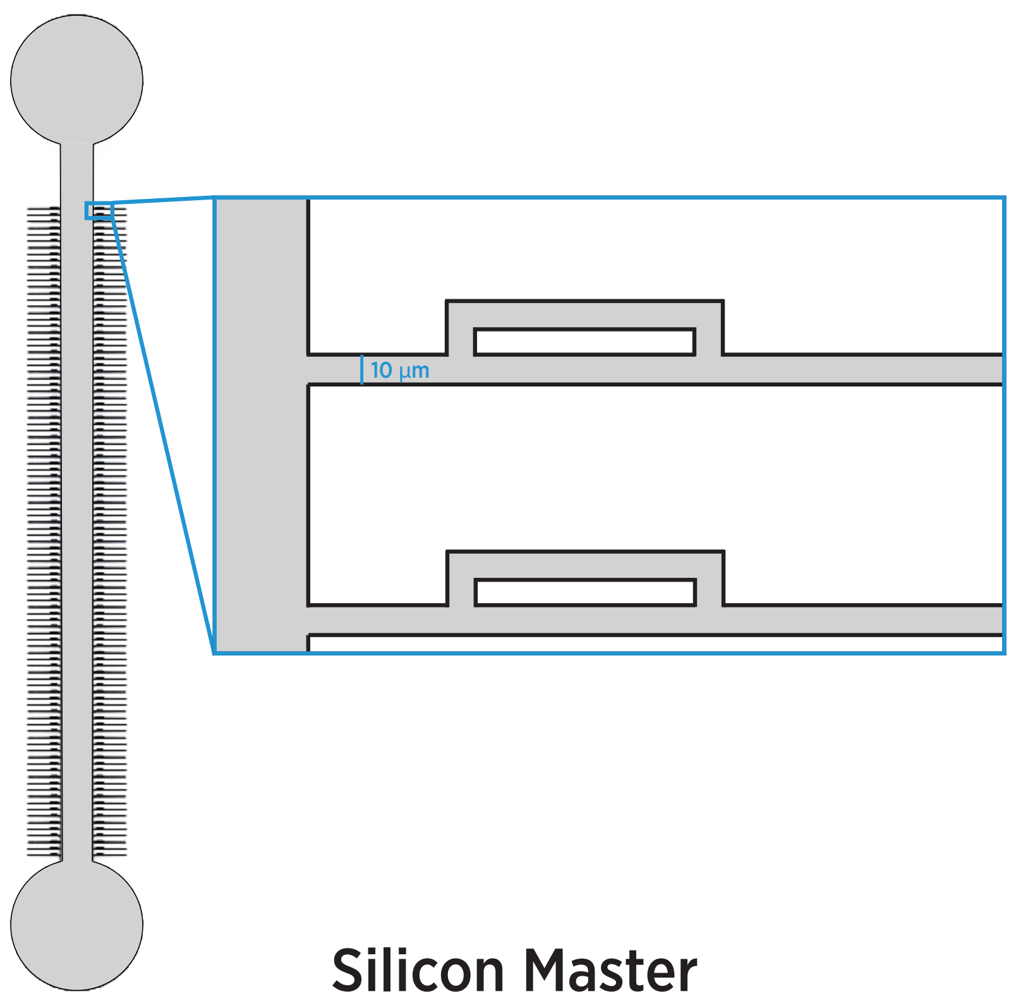


Bottom Platen

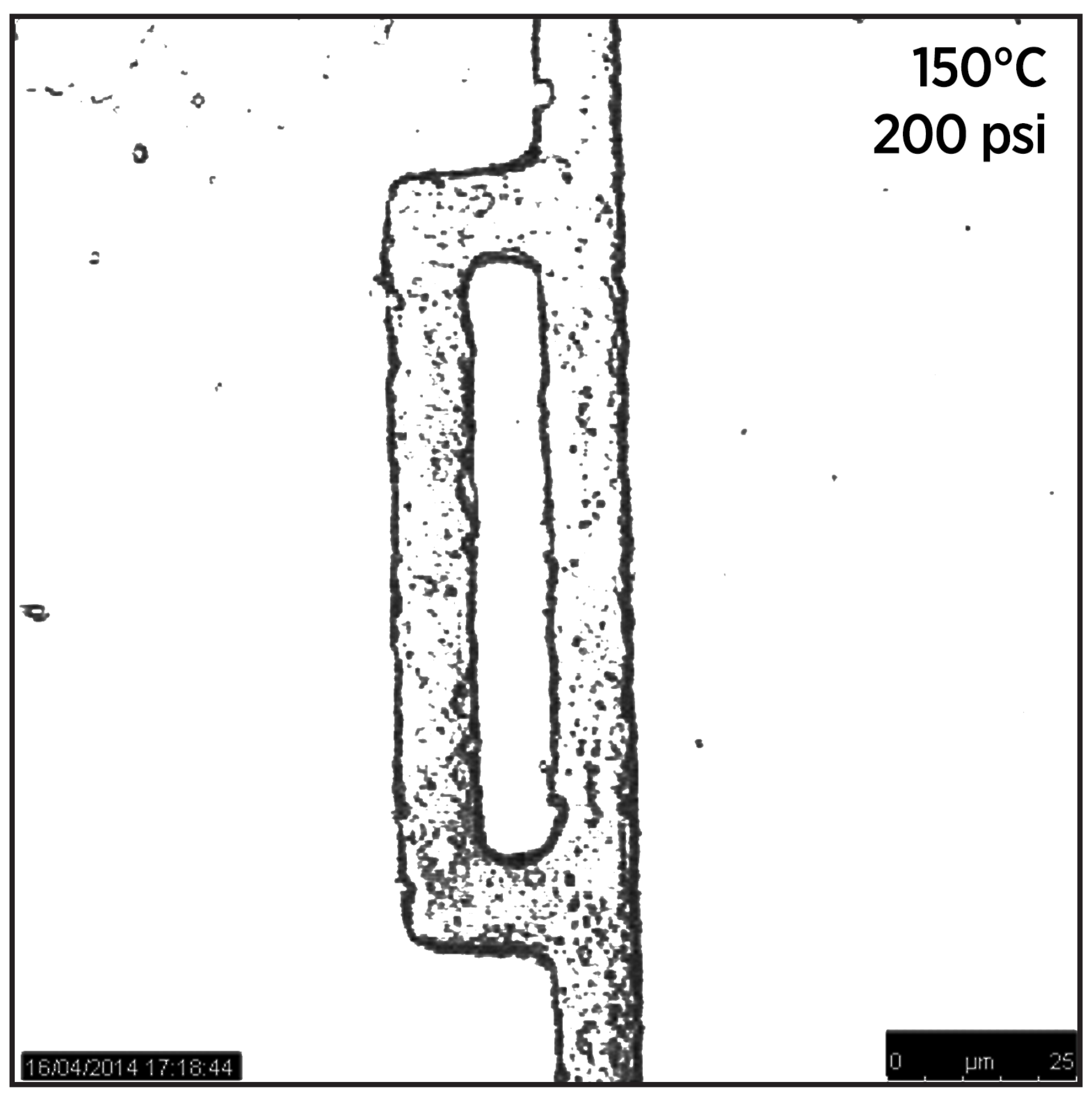
The **platens** were redesigned to minimize cycle time and improve overall chip quality. This was accomplished through reducing the size of the platens to reduce the thermal mass, adding high powered heaters, and improving the interface of the two platens.

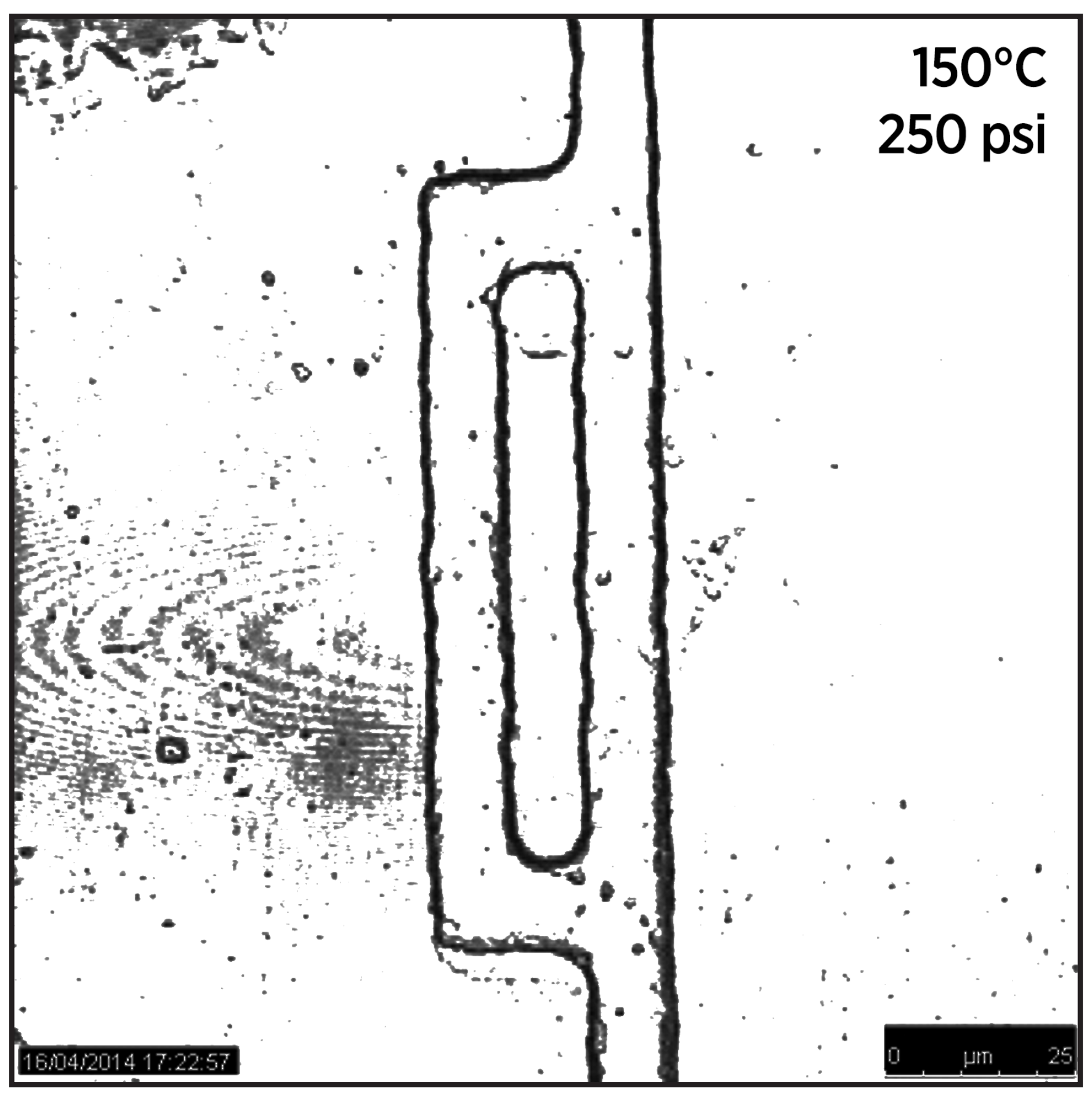
EMBOSSING TESTS

The cross section of the embossed features of a successful chip must be within ±10% of the master features. **Successful chips were embossed at 150°C for 2 minutes with a pressure of 200 psi.** Although chips embossed at 250 psi were equally successful, a lower pressure is desired to prevent silicon master cracking.



Silicon Master





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