



Application Note : Flexdym™ Molding

Using Sublym™ Hot Embossing Machine



Molding.

SUMMARY

This application note describes the thermoforming process of Flexdym™ for microfluidic applications. Flexdym™ is a proprietary styrenic thermoplastic elastomer, developed by Eden Tech. Here, molding is conducted using our Sublym™ press which has been specifically optimized for Flexdym™, however this process can also be achieved using other embossing machine.

The molding process is fast, lasting 2 to 15 minutes from start to finish, depending on the desired results. It can be performed anywhere as the Sublym™ press is ultra-compact (33 x 34 x 11 cm³) and powered only by an electrical plug. The molding protocol is user friendly and no specialized training is required.

INTRODUCTION

Flexdym™ is a soft thermoplastic elastomer combining advantages from both elastomers (e.g. polydimethylsiloxane, PDMS) and hard thermoplastics. Like PDMS, it is a flexible, optically transparent and certified biocompatible polymer (ISO 10993 part 4, 5, 6, 10 and 11 & UPS Class VI), but its production can be more easily streamlined from prototyping to production stages. Unlike most elastomers, Flexdym™ is also compatible with industrial polymer processing techniques, such as injection and extrusion.

Flexdym™ has been created to provide researchers in academia and industry with the choice of a new material for microfluidic biological applications. It can be bond to itself, or to a variety of other materials, including glass and a wide range of thermoplastics (polystyrene, cyclo-olefin copolymer...). Its mechanical properties and characteristics also mean it is suitable for a variety of applications in the life sciences industry, including lab-on-chip, point-of-care devices, organ-on-chip, cosmetics analysis, and environmental studies.

CURRENT FIELD CHANGES

Most materials used in microfabrication require very high initial investment in terms of equipment and training. This can be major deterrent for academic laboratories or small to medium sized companies, looking to explore microfluidics.

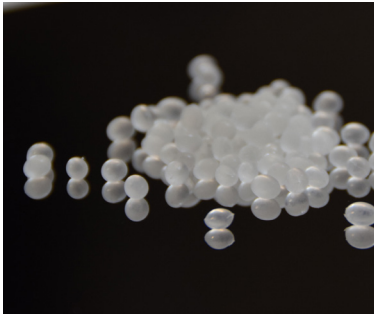
PDMS is considered to be a relatively cost effective and easy to learn option, making it one of the most widely used materials. It is especially popular for producing microfluidic devices for biological applications, because of its high gas permeability, optical transparency, and flexibility.

However, the PDMS microfabrication process uses soft lithography, which may be tedious and time-consuming, easily lasting over 2 hours. There are a multitude of steps involved including mixing, degassing, and multiple curing steps. If the PDMS is not mixed well, the material does not cure. The bonding procedure is also sensitive to the air quality, requiring expensive infrastructure, such as plasma machines and clean room facilities. Dust particles levels must be carefully limited, or else they prevent proper bonding of the chip. Finally, it is primarily a prototyping method, which is difficult to scale up for mass production.

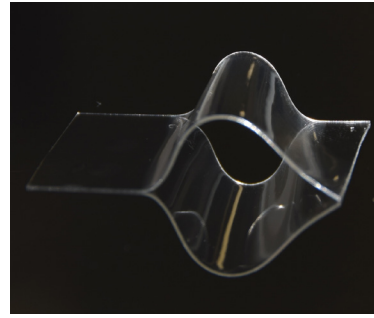
PROTOTYPING & SMALL-SCALE MOLDING VIA HOT EMBOSsing

In contrast, Flexdym™ involves a much lower initial investment. The polymer is set at prices that are comparable to those of PDMS and our Sublym™ press is sold at prices 100-1000X lower than commercial hot embossing and NanoImprint equipment.

Eden Tech supplies Flexdym™ in 3 forms, pellets, 15 cm x 15 cm sheets and rolls. All of these can be molded and are shown in the figures below:



Flexdym™ Pellets



Flexdym™ Sheet

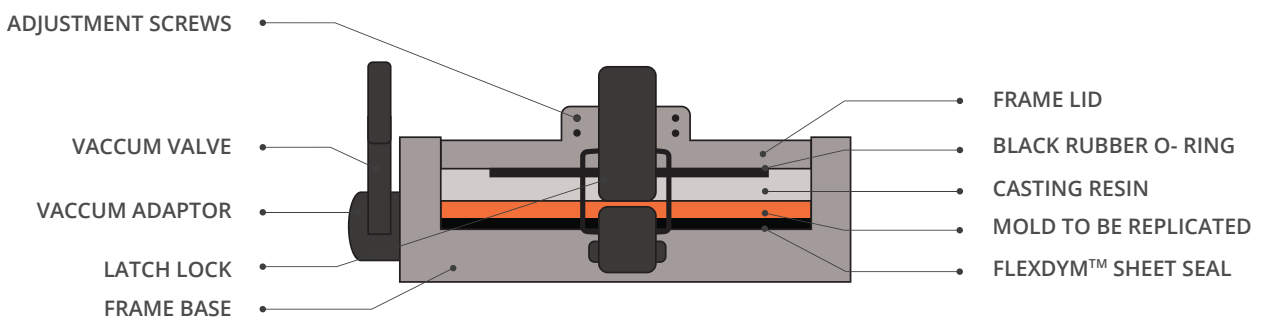
In order to achieve high quality results, we suggest a range of temperatures for different uses, which need to be further optimized by the user for their specific application:

SERVICE TEMPERATURE	
With Mech. Stress	-50°C to 0°C
Without Mech. Stress	-50°C to 100°C
INJECTION PROCESS TEMPERATURE	
Rear	180°C to 230°C
Centre	180°C to 230°C
Front	180°C to 230°C
Mold	20°C to 50°C
EMBOSSING PROCESS TEMPERATURE	
Molding Temp.	120°C to 200°C
Mold Pre-heat	20°C to 180°C

Flexdym™ Thermal Properties

HOT EMBOSSING SETUP USING THE SUBLYM™

Flexdym™ is molded inside the Sublym™ molding chamber by applying pressure with a deformable membrane under vacuum. The schematic below shows the different components of the molding procedure:

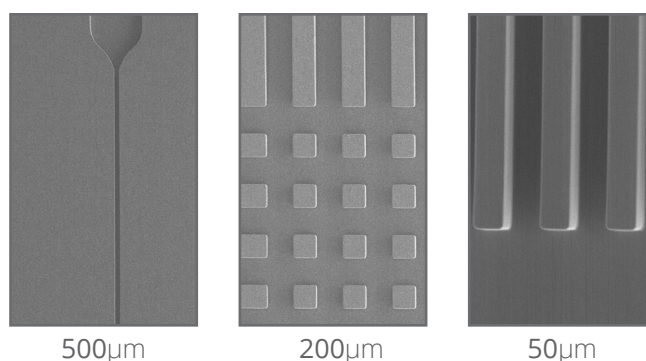


Epoxy™ Kit Principle

STEP-BY-STEP MOLDING USING SUBLYM™

1. In a ductless fume hood, cut the Flexdym™ to a size slightly large than your mold.
2. Remove the protective PTFE sheet from one side of the Flexdym™ and place on the counter mold using tweezers.
 - ⚠ Use isopropanol or ethanol to clean the counter mold beforehand.
3. Remove the second PTFE sheet from the Flexdym™ and place the microfluidic chip mold face down on the Flexdym™ sheet, creating a Mold-Flexdym™-Counter Mold sandwich.
4. Pre-heat the Sublym™ machine to desired temperature.
 - ⚠ Verify the inner deformable membrane of the Sublym™ is correctly attached to lid.
5. Once heated, open Sublym™ and place Flexdym™ sandwich inside molding chamber. Use spacers to adjust the thickness of the Flexdym™ sheet.
6. For small molds: Add a small PTFE sheet on top, to ensure Flexdym™ does not stick to the lid of the chamber.
7. Close the Sublym™ and start the molding process. See Sublym™ user guide for a more detailed step-by-step of the molding process.

The microscopy images below show the results of Flexdym™ molding using the Sublym™. Flexdym™ can be used to mold sub micrometer resolution structures with high reproducibility:



CONCLUSION

Flexdym™ is the first material developed specifically for microfluidics biological applications. It possesses several important characteristics for the life sciences industry, including certified biocompatibility (ISO 10993 part 4, 5, 6, 10 and 11 & UPS Class VI), and optical transparency. Moreover, Flexdym™ provides microfluidics innovators with the ability to streamline and boost your R&D process, by enabling the use of the same material from the prototyping stages through to mass production.

Prototyping and R&D is done via hot embossing, which is a fast and easy microfabrication process, done within minutes. Consequently, researchers can save time on experiments, collect data faster, and aim for higher impact journals. Finally, there is the possibility to transfer your innovation into commercial products.

Mass production of chips is achievable thanks to Flexdym™'s compatibility with industrial polymer processing techniques, such as injection molding.

For those who have little experience in microfluidics or want to produce devices with a low initial investment. By using our Sublym™ compact embossing machine, Flexdym™ sheets can be molded with low financial investments and no special training required.

Finally, the molding of Flexdym™ using the Sublym™ can be performed anywhere. The Sublym™ is a small compact machine, powered only by a plug.

APPENDIX: MOLDING COMPONENT LIST

In order to mold Flexdym™ sheets using the Sublym™, the following components are needed:

- Counter mold treated with silicone lubricant
- Tweezers
- Metal hole punch pliers
- Extra Teflon sheet
- Isopropanol or ethanol
- Heat proof gloves
- Laboratory gloves

REFERENCE

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