# MOR4R: Microwave Oven Recipes for Resins

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## 1. Abstract

This research presents a technique to make an acrylic (PMMA: polymethylmethacrylate) 3D craft using common home electronic equipment, a microwave oven. Though personal fabrication is growing widely popular by the price reduction of digital fabrication tools, the installation of laser cutter at home is still difficult because of issues of safety and health. By pasting properly sized susceptor sheet to the PMMA, and microwaving it about 3 minutes with 800W, the only part where the susceptor is pasted becomes soft enough to bend and cut. The selectability of heating spot allows the creator to form a rigid shape, in the way like folding an origami.

## 2. Background

Personal fabrication is growing widely popular among the person of a DIY spirit by the price reduction of digital fabrication tools such as 3D printer. 3D printer provide us with wide-range of ability of craft at home. Though, modeling using 3D printer is still slow. LaserOrigami [Muller et al 2013] showed faster 3D modeling method using a laser cutter to cut and fold an acrylic (PMMA) sheet simultaneously to make a rigid 3D structure.

However, it is still rare to equip a laser cutter at home because of the cost and safety issue. It requires at least 30W of laser to cut 5mm thickness of PMMA sheet. Of course, this output is harmful to the human body, especially the eyes. Moreover, the volatilized gas that is generated by cutting PMMA sheet should be processed properly [Zhou B. H. et al 2004].

Meanwhile, since PMMA is thermoplastic, it becomes possible to bend by hand when heated up using an electric pan or an acrylic bending heater, and it becomes hard again when cooled down. Nevertheless, using these tools, it is still difficult to heat up localized multipoint simultaneously.

To solve this problem, we present a simple but widely applicable method called "MOR4R" that enable makers to select heating areas by putting a thin film on a piece of PMMA sheet. With this method, all the equipment that the makers need is a common microwave oven.

## 3. Exposition

MOR4R means Microwave Oven Recipes for Resins. In this method, a kind of susceptor sheet (RSR-1, Sunnap Co., Ltd.) is used for the heat control. Susceptor is a kind of evaporated aluminum film that can absorb microwave and get hot without making any spark. The temperature reaches about 120°C with 3 minutes microwaving (800W). By pasting susceptor sheet to a piece of PMMA sheet using double sided tape, the only part where the sausceptor is pasted becomes soft enough to bend by hand, because the glass transition temperature of standard PMMA is around 100 degrees. It can be bent and cut with hands and scissors by holding the part where is not heated.

**Figure 1:** *MOR4R*

One of the most outstanding characteristics of this approach is the selectability of heating spot. Though it is easy to melt linear or planar area using an acrylic bending heater, a hot blower or an electric pan, it is still difficult to heat up small areas, curved line, and organic shaped area. With our method, it is also able to heat multiple points simultaneously.

The simultaneous heating for selected area means enhancing designability of resin materials. The creator can choose where to soften, and the melted line helps him/her to fold the resin sheet.

In addition, microwave oven is very popular home equipment. The most of us already have own microwave oven in the kitchen. Moreover, this method never uses toxic volatile chemicals. Also, this method never generates gas and dust that is harmful to the human body. Though PMMA requires around 400°C to make fire, the temperature generated by the susceptor is up to around 140°C by 5 minutes microwaving (800W).

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## References

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