Resolution, print size, and accuracy dependencies

When it comes to 3D printing, you often hear about resolution, print size, and accuracy. They are often discussed, but they are difficult to understand. Today, let's figure out the relationship between them.

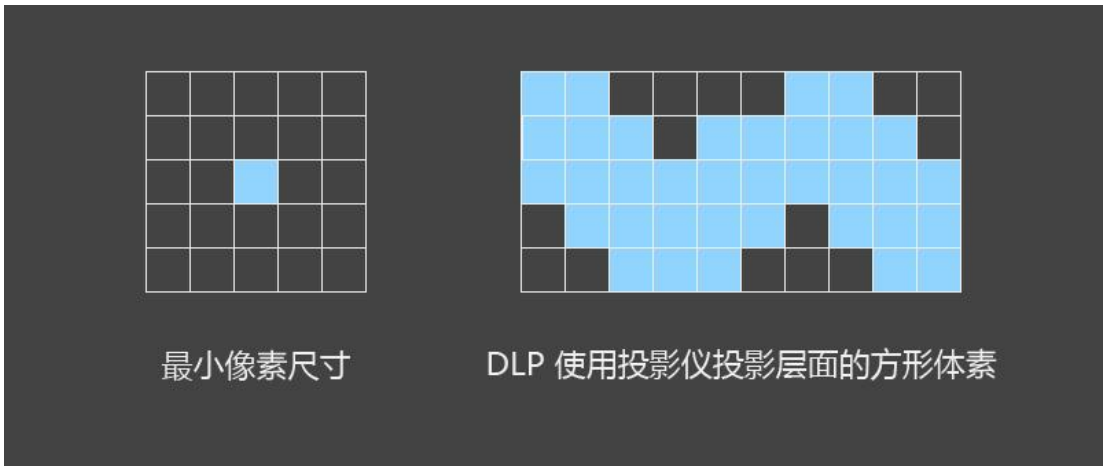
1. Screen resolution and print size

Resin 3D printing includes three common printing methods: stereolithography (SLA), digital light processing (DLP), and liquid crystal display (LCD), which use different light sources to solidify the model and form it layer by layer.

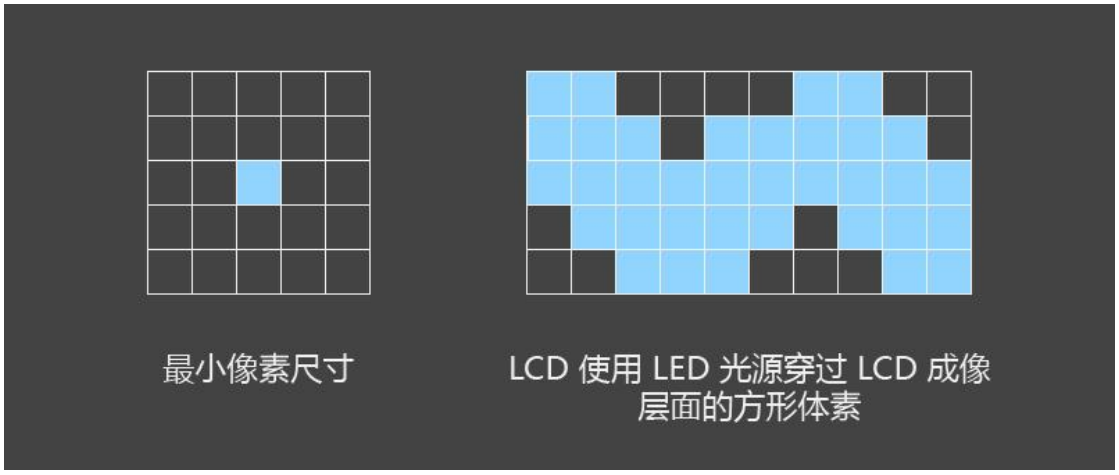
In general, we often refer to resolution as the number of pixels on the screen. Similarly, for 3D printing, resolution refers to a certain number of pixel points imaged under light sources, such as laser light sources for SLA, projection light sources for DLP, and LED light sources for LCD. To understand the differences among the three types of photocuring, SLA/DLP/LCD, it is first necessary to understand their imaging principles.

SLA is the process of using ultraviolet lasers to outline each layer of the model, driven by two galvanometers connected to electrical motors, known as "galvanometers" or "galvanometers" (one on the X axis and one on the Y axis). Two mirrors quickly aim the laser at the target printing area, moving it while solidifying the resin. In order to print out a physical object, an SLA must decompose the entity layer by layer into a series of points and lines, which are passed to the "galvanometer" to form a set of coordinates, and the laser will track their imaging trajectory.

DLP uses a digital projector to project a single image of each layer on the entire platform at once. Because the image of each layer is displayed digitally, it is composed of many cube elements.



LCD (MSLA) is almost the same as DLP, but LCD (MSLA) is an LED light source rather than a projector light source. The screen acts as a mask, displaying only the pixels required for the current layer.



The printing accuracy is proportional to the number of pixels and inversely proportional to the print size.

For example, if the molding width of a printer in the X-axis direction is 68mm and the number of pixels in the X-axis direction is 1440, the pixel accuracy in the X-axis direction is:

$$\frac{68mm}{1440px} \approx 47\mu m$$

The Y-axis direction is the same. It should be noted that because each pixel contains TFT elements and there is a gap between adjacent pixels, the effective exposure area of each pixel will be slightly smaller than the calculated individual pixel area here.

Typically, people use pixels per inch (PPI) to measure the pixel accuracy of a screen:

$$PPI = \frac{\sqrt{x^2 + y^2}}{\text{屏幕对角线长度}}$$

The higher the PPI, the higher the pixel accuracy.

If the resolution and print size do not match when set, the model will be distorted and distorted.

Among the many factors that affect 3D printing, none has a greater impact on accuracy than the resolution (minimum imaging accuracy) of the XY axis. The XY axis resolution is the minimum imaging size at which a light source cures a line or layer in the horizontal direction. Generally speaking, the smaller the pixel accuracy, the better the detail rendering.

2. Layer thickness

Resolution and screen size together determine the accuracy of the model in the XY direction, while layer thickness determines the accuracy of the model in the Z direction. Layer thickness refers to the relative displacement distance of the printing platform in the Z direction before each exposure compared to the previous exposure. The smaller the layer thickness, the higher the model accuracy, and of course, the longer the printing time it takes. The printing platform is controlled by a stepper motor through a screw rod. In theory, the minimum movement distance is related to the step angle of the stepper motor and the lead of the screw rod (the displacement distance of a rotation of the screw rod), but it may also be limited by slicing software.

Minimum moving distance=$\frac{Screw\ lead}{Stepper\ motor\ rotation - total\ number\ of\ steps\ in\ a\ circle\ (including\ subdivisions)}$

Taking a step angle of 1.8 °, 16 subdivisions, and a lead of 2mm as an example,

$$\text{最小移动距离} = \frac{2mm}{\frac{360°}{1.8°} \times 16\text{细分}} = 0.625\mu m$$

In addition to screen resolution and layer thickness, there are many other factors that need to be considered. When starting 3D printing, be patient and don't expect perfect print quality from the beginning. Experience is accumulated through trial and error. Finally, it is important to emphasize that accurate 3D slicing settings are particularly important for 3D printing quality.