



3D PRINTING training material -from file to Yoda-

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Why FDM 3D printing?

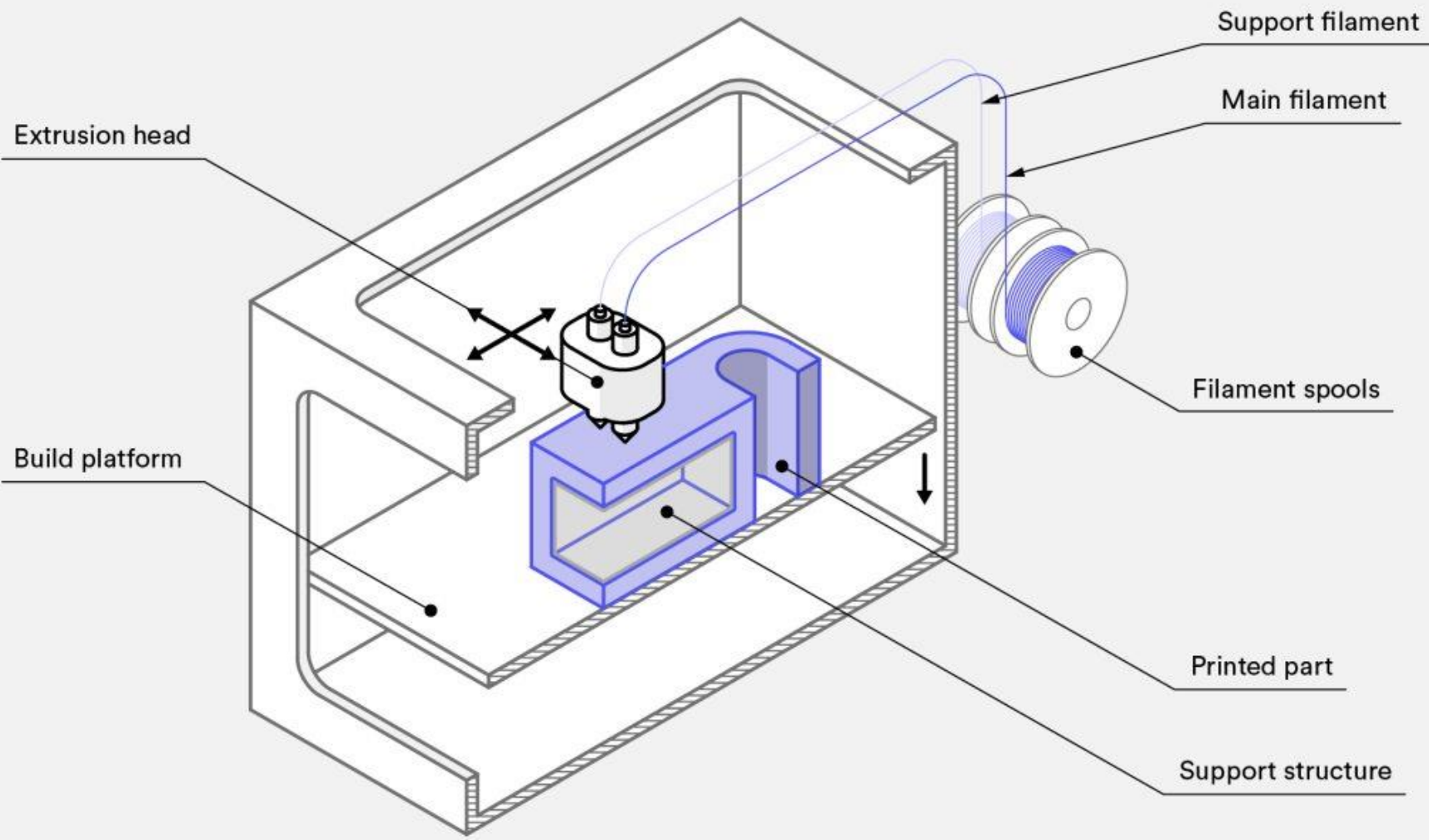
- ▶ Fused Deposition Modeling, also known as FDM 3D printing, is an affordable 3D printing technique and an excellent choice for quick, low-cost prototyping.

FDM materials

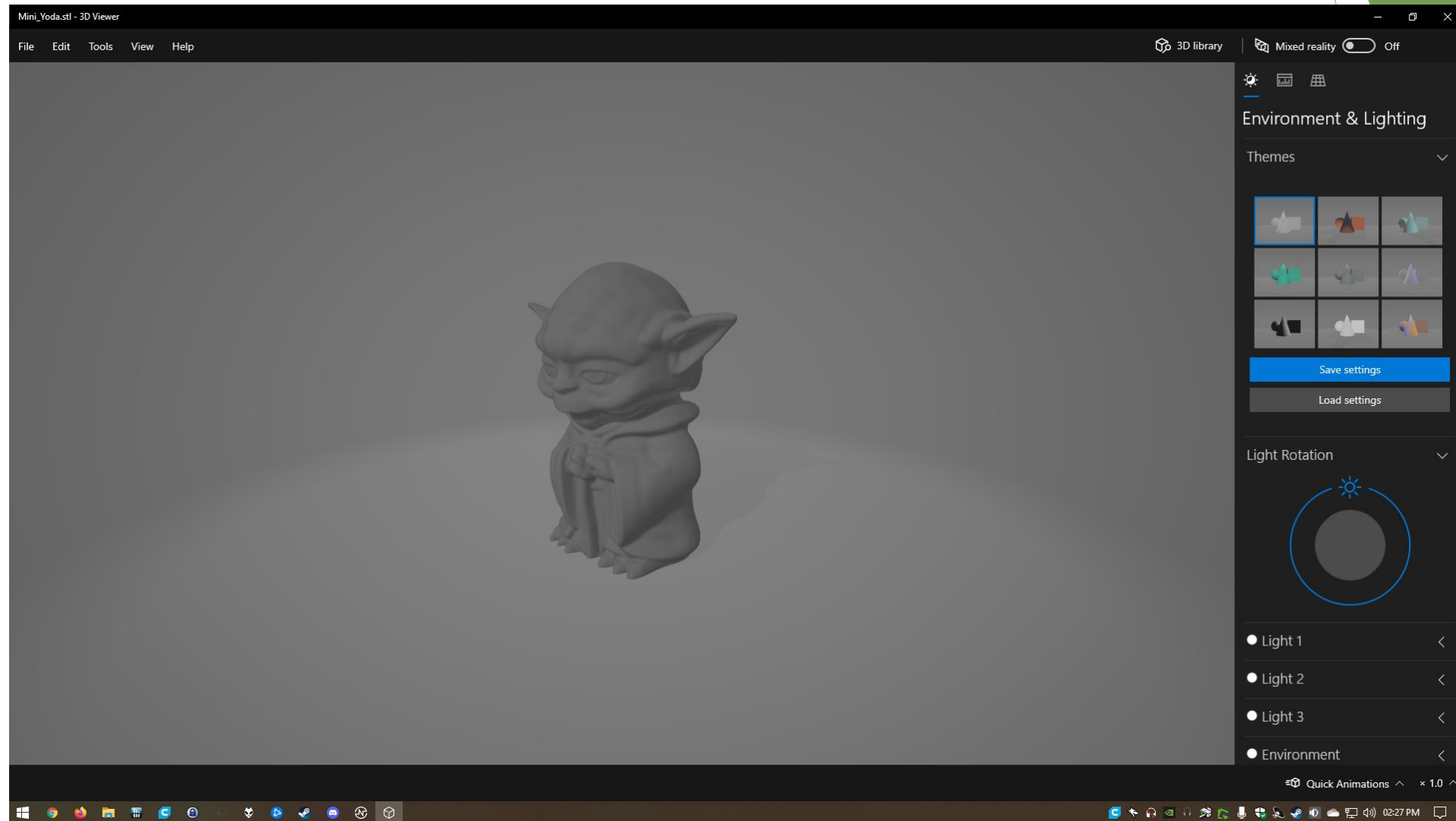
- ▶ Fused deposition modeling (FDM) is also known as fused filament fabrication (FFF), an additive manufacturing process. In FDM, an object is built by selectively depositing melted material in a predetermined path, layer by layer. The materials used are thermoplastic polymers, which come in a filament form.

How does FDM work?

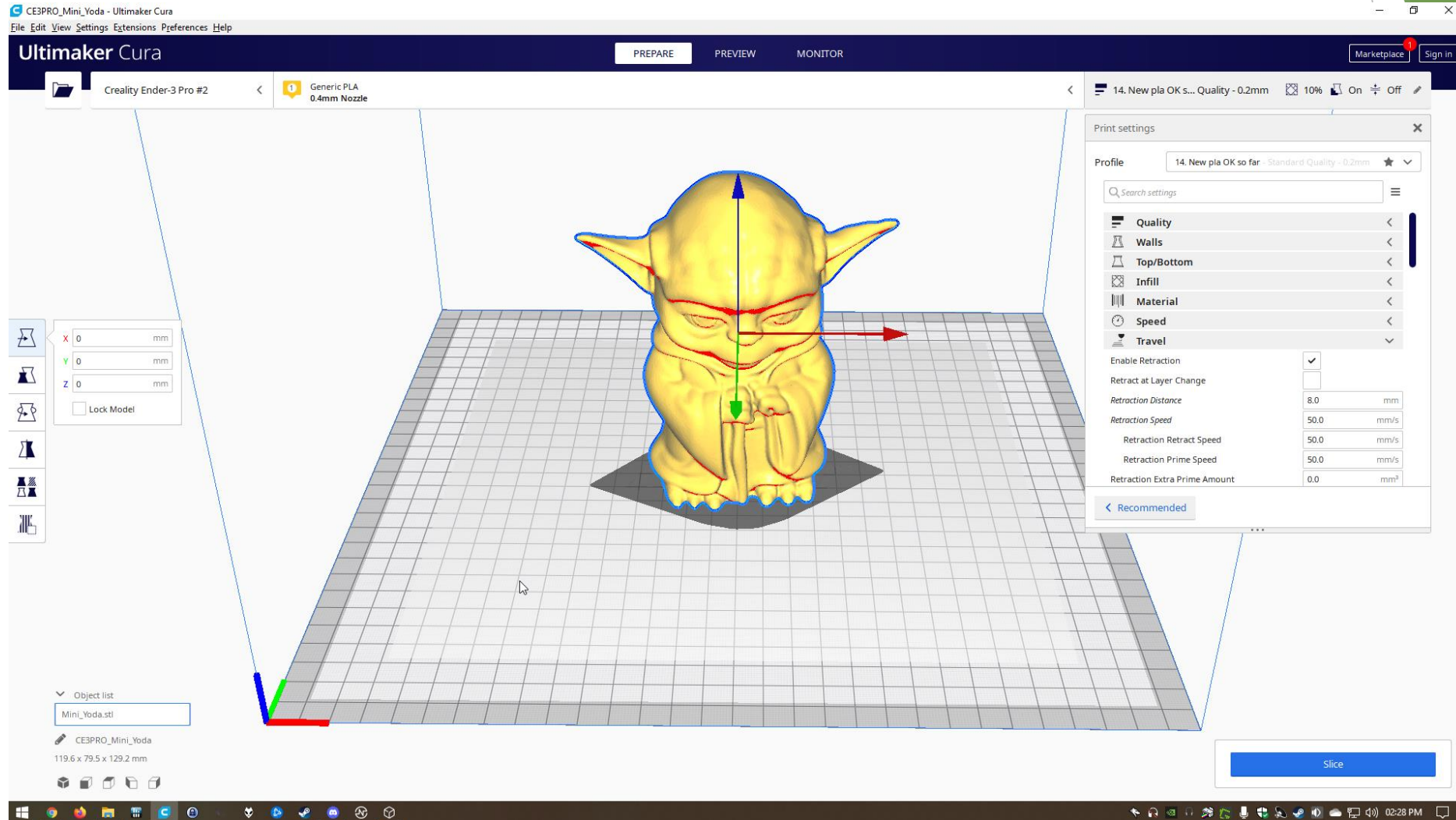
- ▶ The FDM fabrication process works by first loading a spool of thermoplastic filament into the printer. Once the nozzle has reached the desired temperature, the filament is fed into the extrusion head and nozzle, where it melts.
- ▶ The extrusion head is attached to a three-axis system that allows it to move in the x-, y- and z- directions. Melted material is extruded in thin strands and deposited layer by layer in predetermined locations, where it cools and solidifies. Fans can be attached to the extrusion head to accelerate the cooling.
- ▶ To fill an area, multiple passes are required, similar to coloring in a rectangle with a marker. When a layer is finished, the build platform moves down (or in some machine setups, the extrusion head moves up) and a new layer is deposited. This process is repeated until the part is complete.



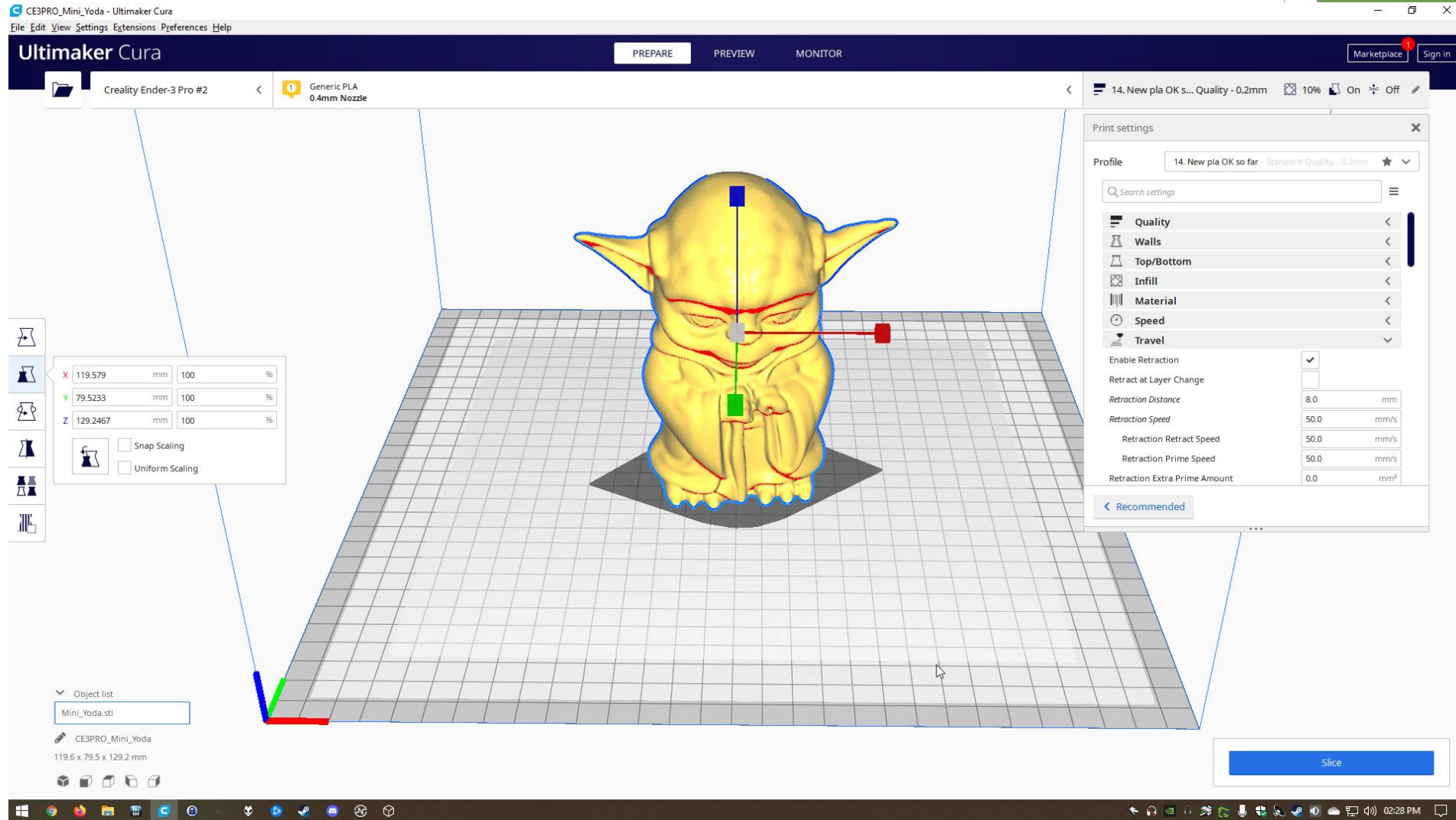
1. The base STL file



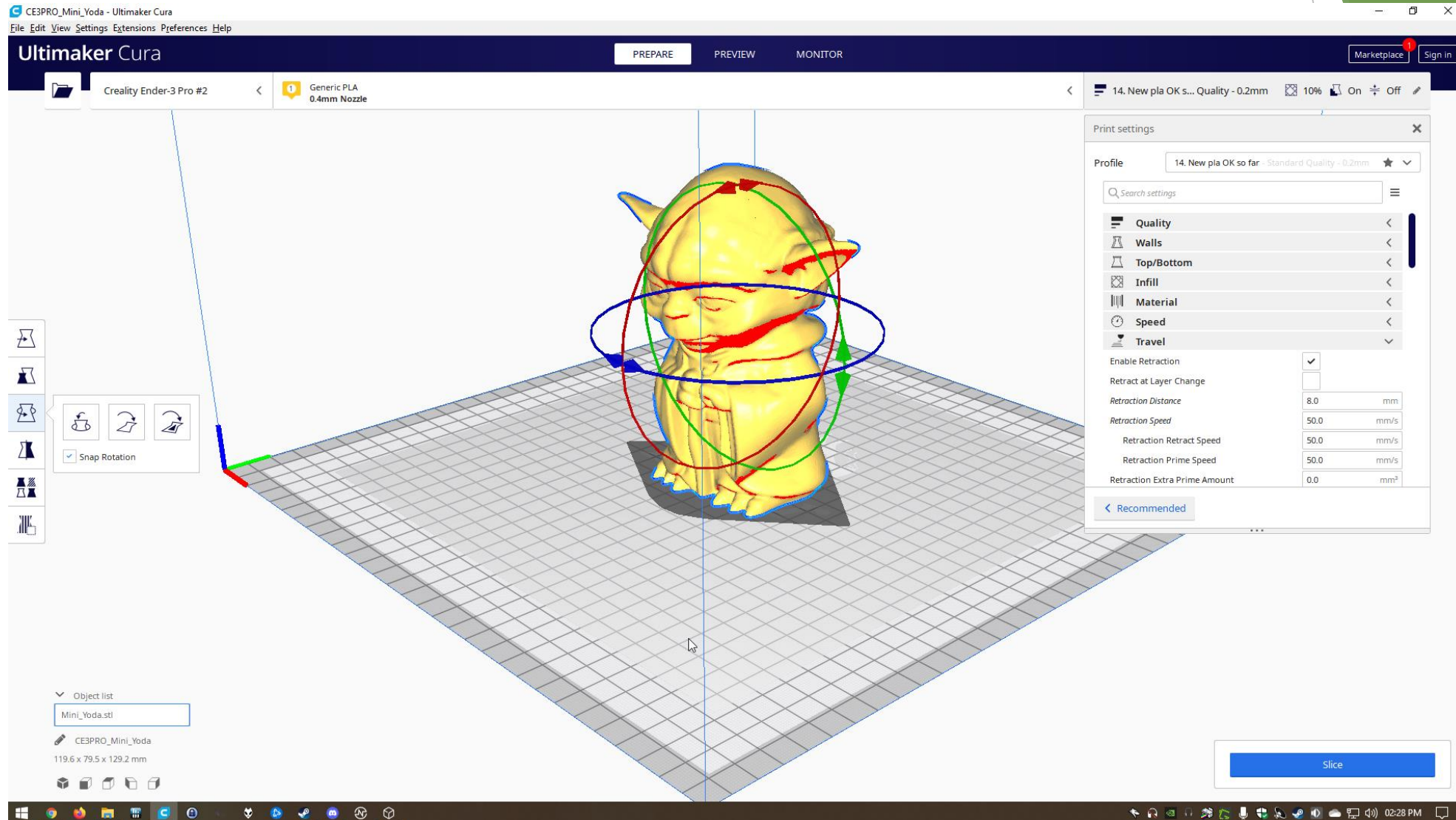
2. Position



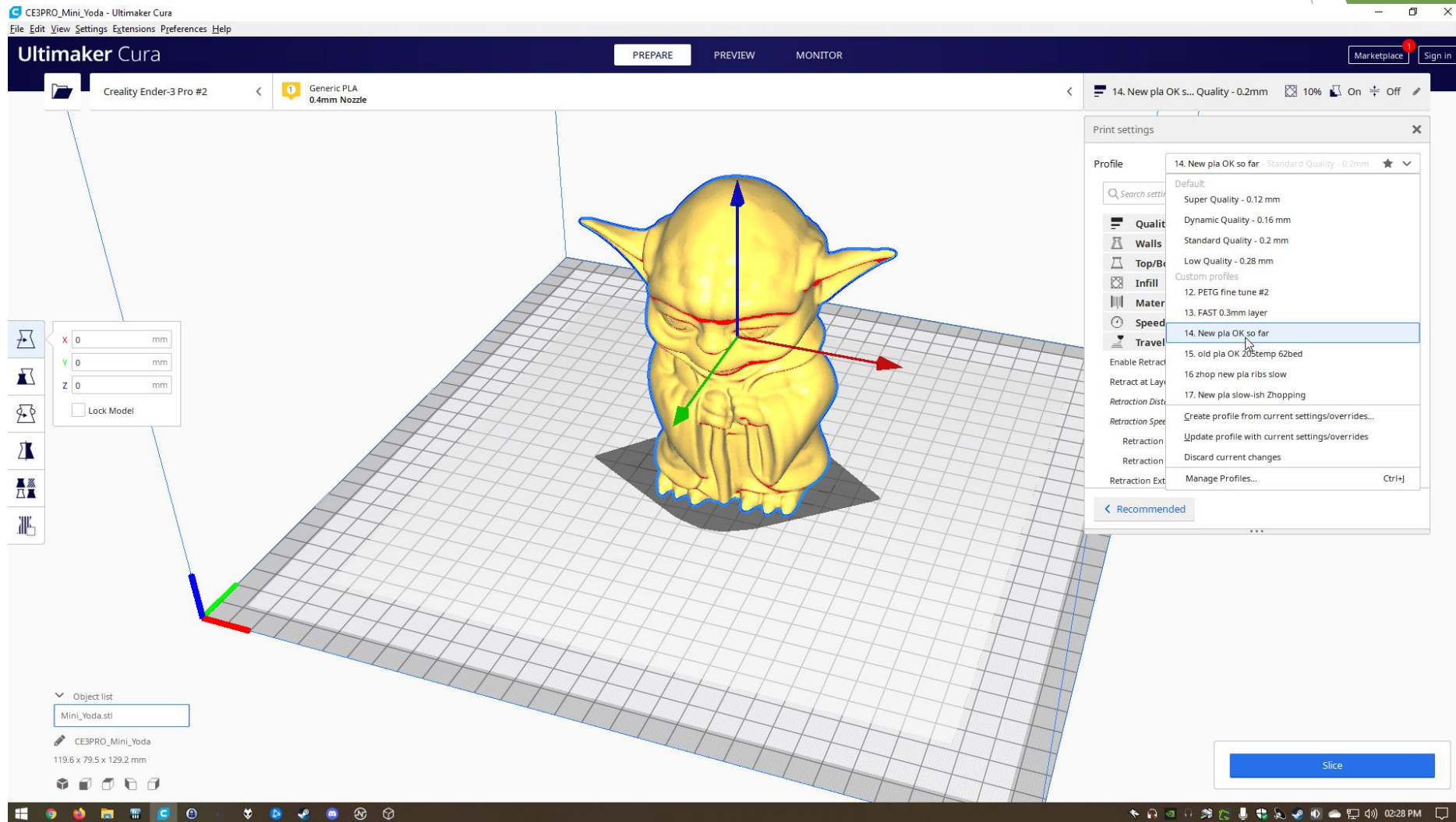
3. Scaling



4. Rotation



5. Ultimaker Cura profiles selection



7. Quality settings

The screenshot shows the Ultimaker Cura interface. The main window displays a 3D model of a yellow Yoda head on a grid. A tooltip for 'Inner Wall(s) Line Width' is visible, explaining that it is the width of a single wall line for all wall lines except the outermost one. The tooltip lists affected settings: Wall Line Count, Skin Overlap, Skin Removal Width, Skin Expand Distance, Cubic Subdivision Shell, and Infill Overlap. The affected settings list includes Wall Line Width.

The Print settings panel on the right shows the following Quality settings:

Setting	Value	Unit
Layer Height	0.2	mm
Initial Layer Height	0.2	mm
Line Width	0.4	mm
Wall Line Width	0.4	mm
Outer Wall Line Width	0.4	mm
Inner Wall(s) Line Width	0.4	mm
Top/Bottom Line Width	0.4	mm
Infill Line Width	0.4	mm
Skirt/Brim Line Width	0.4	mm
Support Line Width	0.4	mm
Support Interface Line Width	0.4	mm
Support Roof Line Width	0.4	mm
Support Floor Line Width	0.4	mm

The interface also shows the 'Object list' at the bottom left with 'Mini_Yoda.stl' and 'CE3PRO_Mini_Yoda' (119.6 x 79.5 x 129.2 mm). The Windows taskbar at the bottom shows the time as 02:29 PM.

8. Infill settings

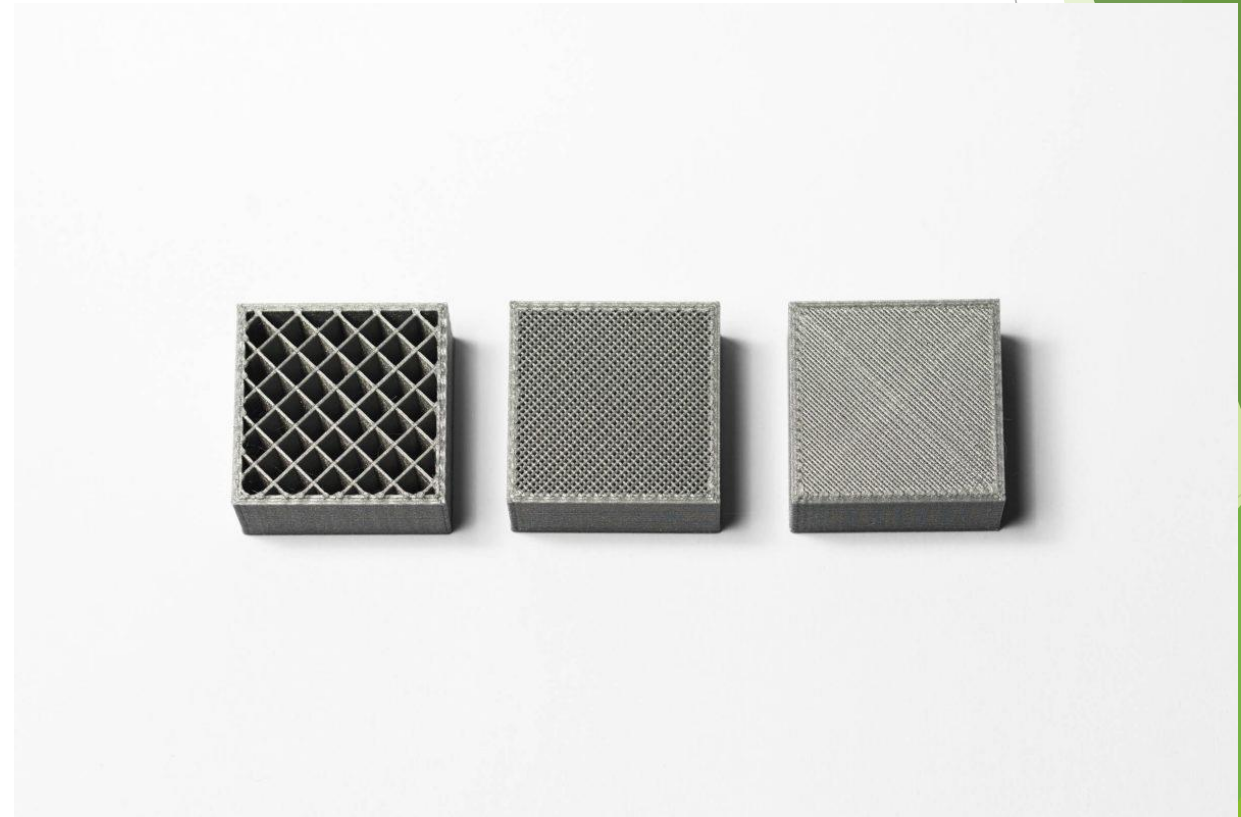
The screenshot displays the Ultimaker Cura interface. In the center, a yellow 3D model of a Yoda head is shown on a grid. A tooltip with a red arrow points to the 'Randomize Infill Start' checkbox in the settings panel, containing the text: "Randomize Infill Start. Randomize which infill line is printed first. This prevents one segment becoming the strongest, but it does so at the cost of an additional travel move." The settings panel on the right is titled "Print settings" and shows the "Infill" section with the following values:

Setting	Value	Unit
Infill Density	10.0	%
Infill Line Distance	4.0	mm
Infill Pattern	Zig Zag	
Infill Line Directions	[1]	
Infill X Offset	0.0	mm
Infill Y Offset	0.0	mm
Randomize Infill Start	<input type="checkbox"/>	
Extra Infill Wall Count	0	
Infill Overlap Percentage	30.0	%
Infill Overlap	0.12	mm
Infill Wipe Distance	0.0	mm
Infill Layer Thickness	0.2	mm
Gradual Infill Steps	0	

At the bottom of the settings panel, there is a "Recommended" button and a "Slice" button. The top of the interface shows the "PREPARE" tab and various window controls. The bottom of the screen shows the Windows taskbar with the time 02:29 PM.

The internal geometry of FDM prints

To reduce print time and save on material, FDM parts are usually not printed solid. Instead, the outer perimeter—called the shell—is traced using several passes, and the interior—called the infill—is filled with an internal low-density structure.



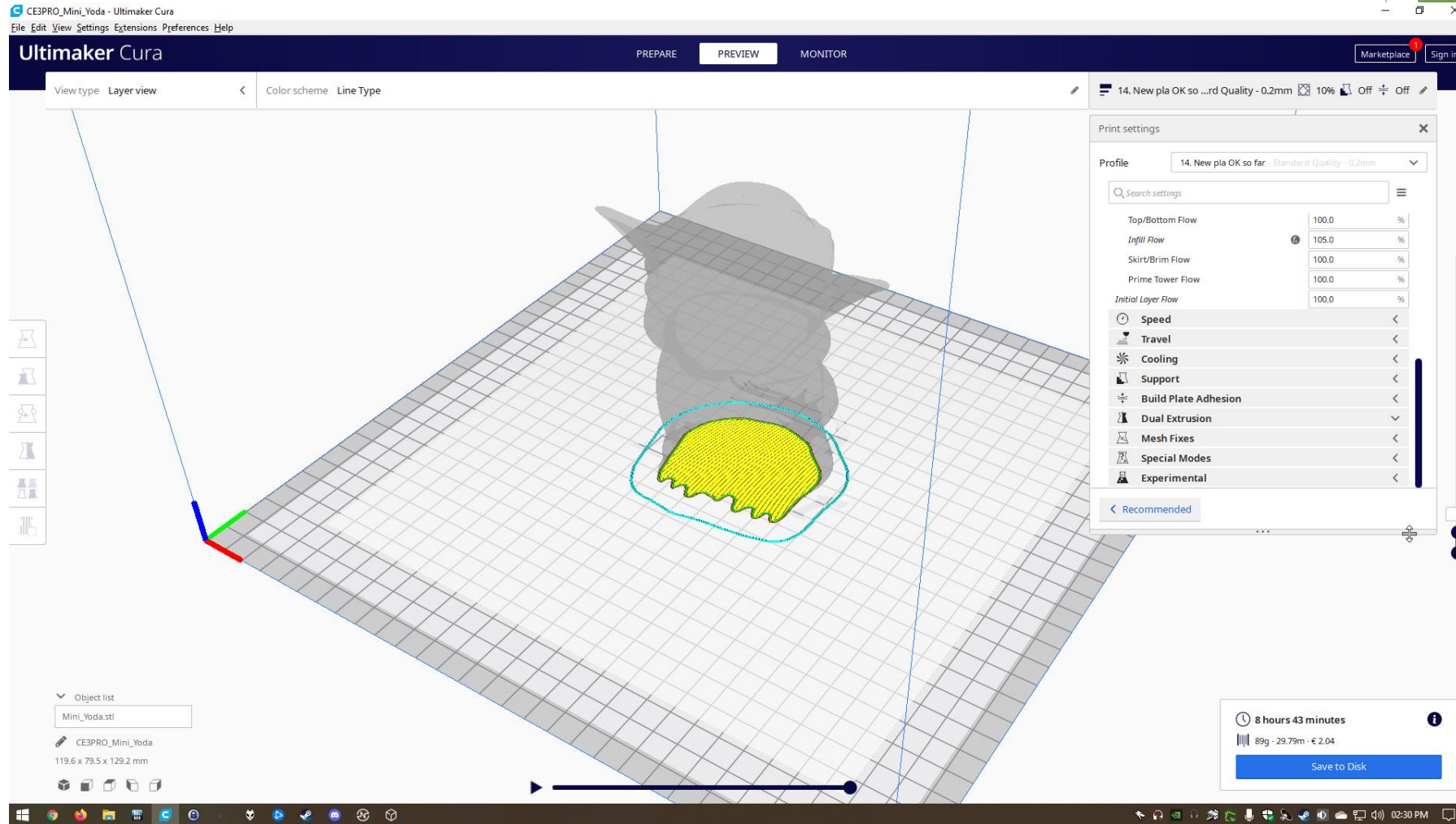
9. Material settings

The screenshot displays the Ultimaker Cura software interface. The main window shows a 3D model of a yellow Yoda figure on a grid. The interface includes a top menu bar with 'File', 'Edit', 'View', 'Settings', 'Extensions', 'Preferences', and 'Help'. Below the menu bar, there are tabs for 'PREPARE', 'PREVIEW', and 'MONITOR'. The current project is 'Creality Ender-3 Pro #2' using 'Generic PLA 0.4mm Nozzle'. The right-hand panel is open to 'Print settings' for a profile named '14. New pla OK so far - Standard Quality - 0.2mm'. The settings are as follows:

Parameter	Value	Unit
Printing Temperature	210.0	°C
Printing Temperature Initial Layer	215.0	°C
Initial Printing Temperature	210.0	°C
Final Printing Temperature	210.0	°C
Build Plate Temperature	68.0	°C
Build Plate Temperature Initial Layer	69.0	°C
Flow	100.0	%
Wall Flow	100.0	%
Outer Wall Flow	100.0	%
Inner Wall(s) Flow	100.0	%
Top/Bottom Flow	100.0	%
Infill Flow	105.0	%
Skirt/Brim Flow	100.0	%
Support Flow	100.0	%

The 'Object list' at the bottom left shows 'Mini_Yoda.stl' with dimensions '119.6 x 79.5 x 129.2 mm'. A 'Slice' button is located at the bottom right of the settings panel.

First layer



Layer 387

The screenshot displays the Ultimaker Cura software interface. The main 3D view shows a Yoda head model with a red skirt, where the top layer is highlighted in yellow and green, indicating the current layer being processed. The interface includes a top menu bar with 'File', 'Edit', 'View', 'Settings', 'Extensions', 'Preferences', and 'Help'. Below the menu bar, there are buttons for 'PREPARE', 'PREVIEW', and 'MONITOR'. The right side of the interface features a 'Print settings' panel with various parameters such as 'Top/Bottom Flow', 'Infill Flow', 'Skirt/Brim Flow', 'Prime Tower Flow', 'Initial Layer Flow', 'Speed', 'Travel', 'Cooling', 'Support', 'Build Plate Adhesion', 'Dual Extrusion', 'Mesh Fixes', 'Special Modes', and 'Experimental'. The bottom status bar shows the estimated print time as '8 hours 43 minutes', the material weight as '89g', and the volume as '29.79m³'. A 'Save to Disk' button is also visible in the bottom right corner.

CE3PRO_Mini_Yoda - Ultimaker Cura
File Edit View Settings Extensions Preferences Help

Ultimaker Cura PREPARE PREVIEW MONITOR Marketplace Sign in

View type Layer view Color scheme Line Type

14. New pla OK so ...rd Quality - 0.2mm 10% Off Off

Print settings

Profile 14. New pla OK so far - Standard Quality - 0.2mm

Search settings

Top/Bottom Flow	100.0	%
Infill Flow	105.0	%
Skirt/Brim Flow	100.0	%
Prime Tower Flow	100.0	%
Initial Layer Flow	100.0	%

Speed <
Travel <
Cooling <
Support <
Build Plate Adhesion <
Dual Extrusion <
Mesh Fixes <
Special Modes <
Experimental <

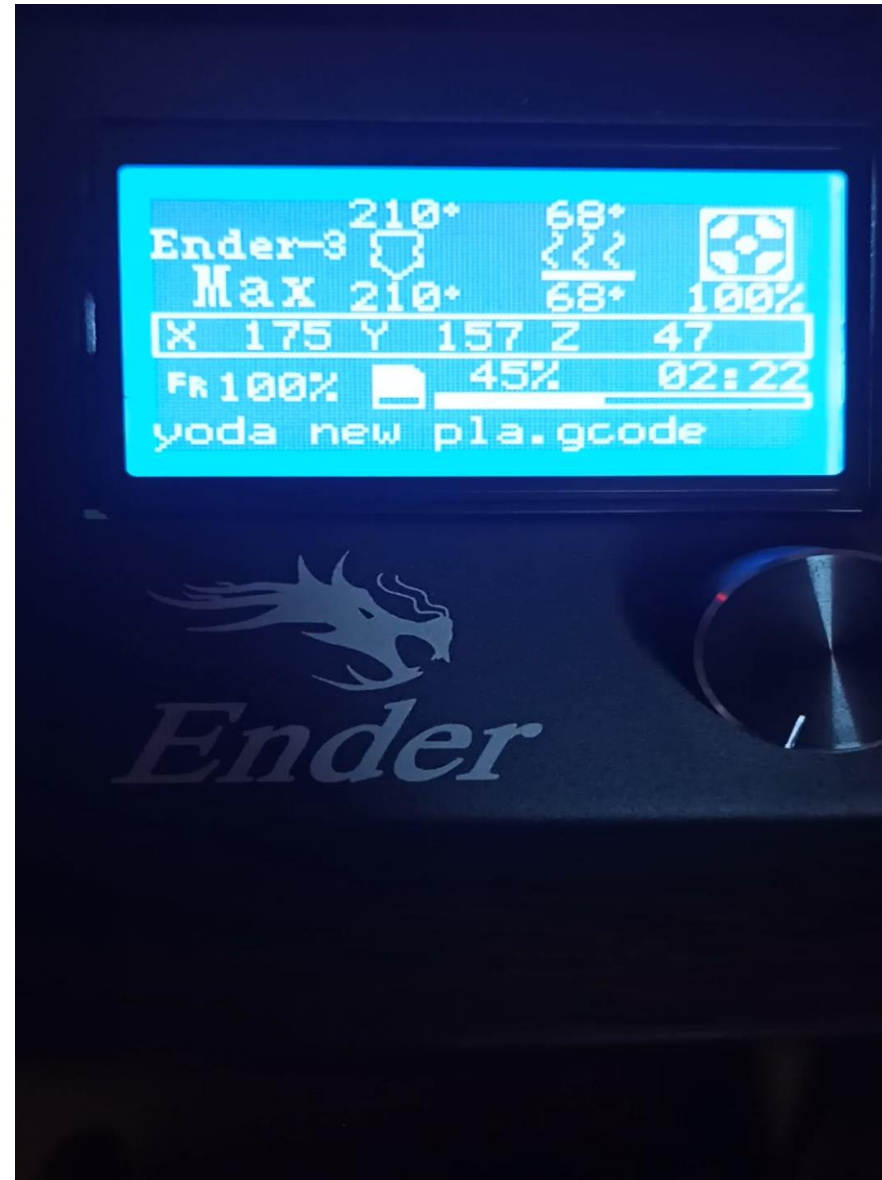
< Recommended

Object list
Mini_Yoda.stl
CE3PRO_Mini_Yoda
119.6 x 79.5 x 129.2 mm

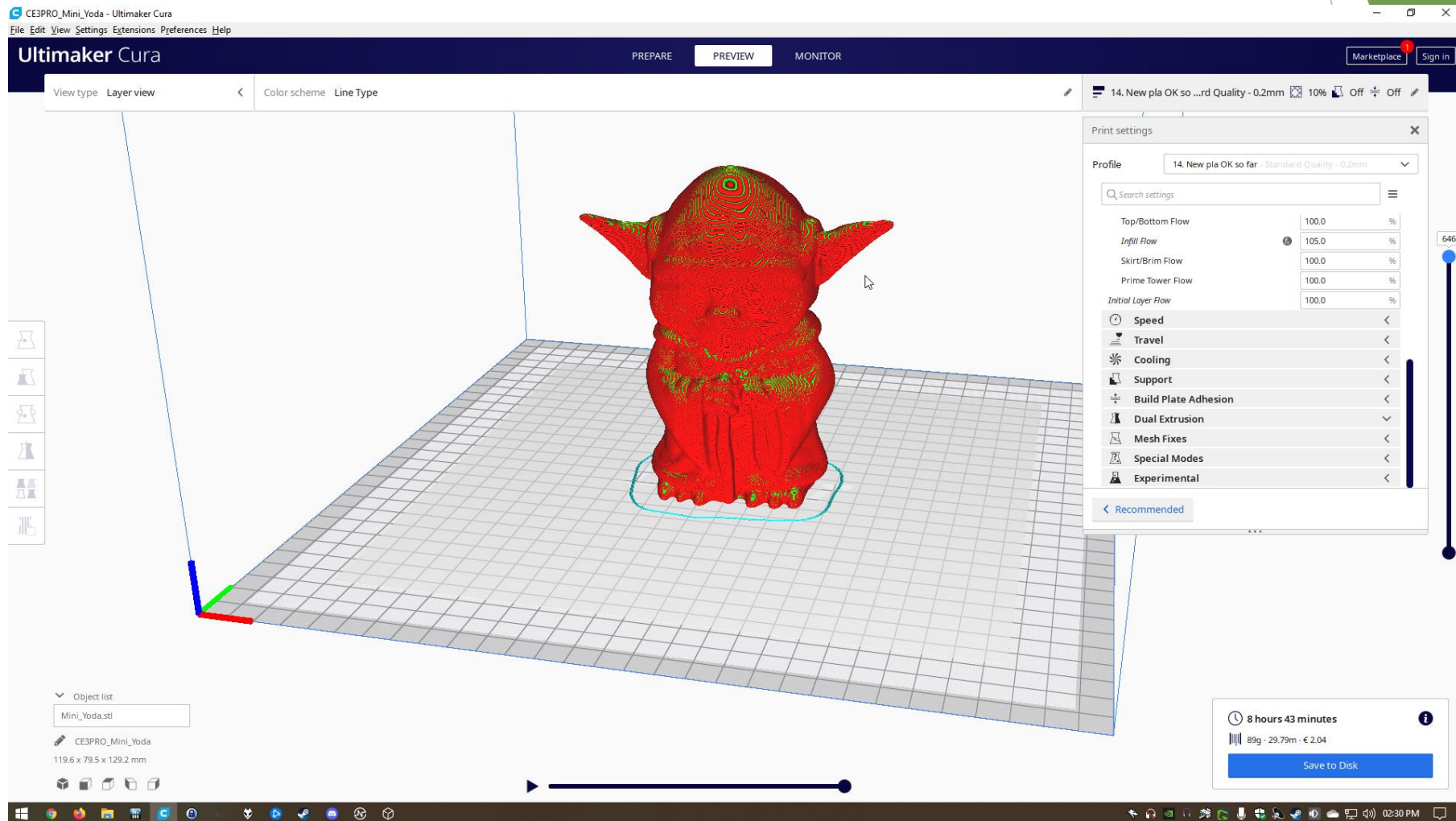
8 hours 43 minutes
89g · 29.79m³ · € 2.04
Save to Disk

02:30 PM

Work in
progress



Finished product



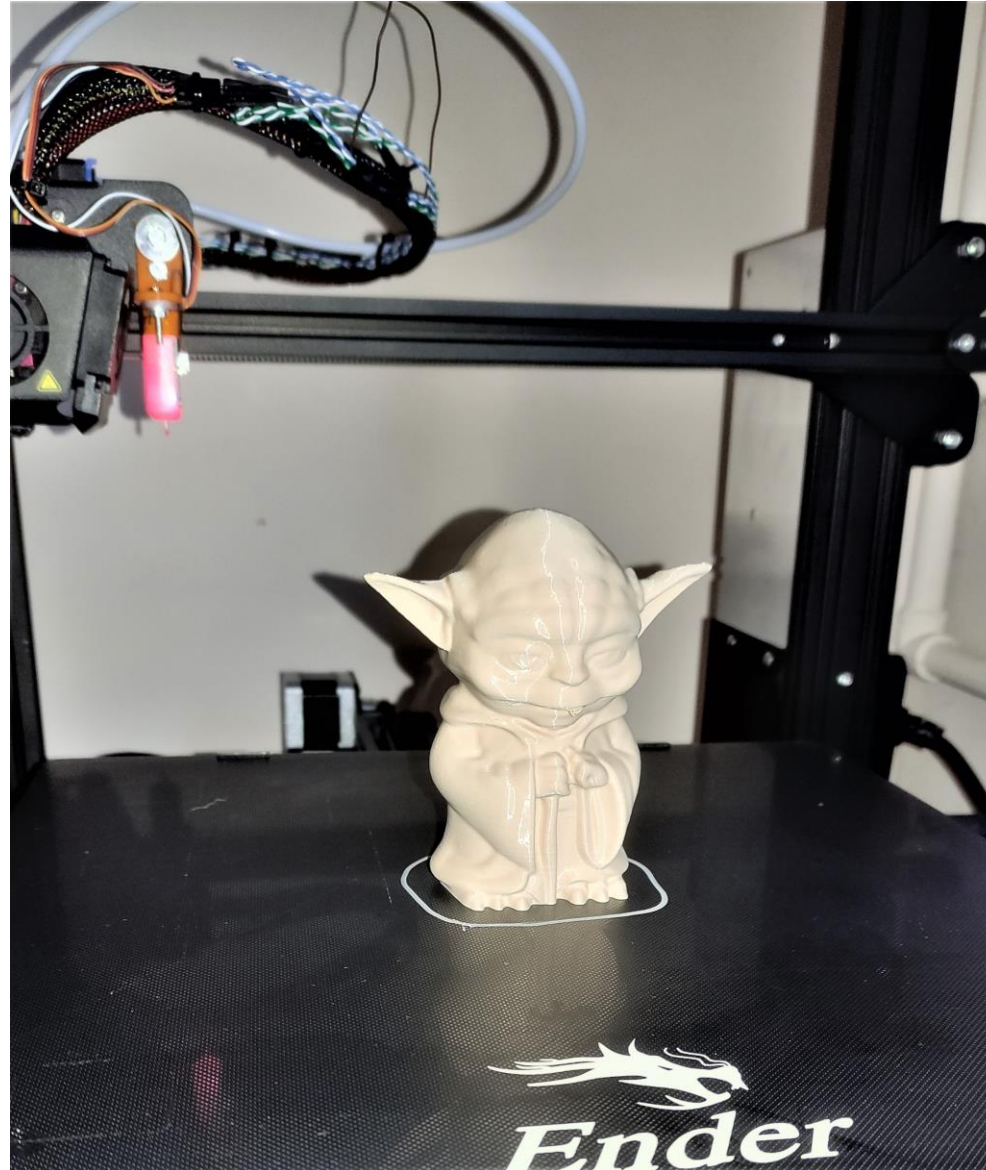
What are the advantages of FDM 3D printing?

- ▶ FDM is the most cost-effective way to produce custom thermoplastic parts and prototypes.
- ▶ Lead times are short (typically a few days) due to the ubiquity of the technology.
- ▶ A wide range of materials is available, suitable for both prototyping and some functional applications.

What are the disadvantages of FDM 3D printing?

- ▶ FDM has the lowest resolution compared to other 3D printing technologies, so it is not suitable for parts with very small details.
- ▶ Parts are likely to have visible layer lines, so post-processing is required for a smooth finish.

May
the
Force
be
with
you!



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