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## Parallel Ironing in FFF Printing

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**Title: Parallel ironing in FFF printing**

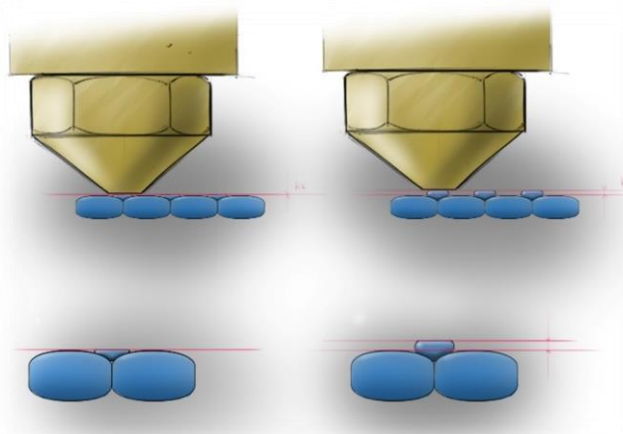
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**Abstract:** A new method of FFF (Fused Filament Fabrication) printing is proposed. The method can be performed using an FFF printing device. The purpose of the proposed method is to increase the 3D printed parts strength in Z-axis improving the mechanical properties of a part. This is achieved by using parallel ironing on each layer or with a given strategy of application.

Parallel ironing is used to refer to a new process wherein a nozzle is moved parallel to the layer lines selectively above their contact line extruding enough material to fill in the naturally formed voids between those lines, see left side of Figure 1. Another possible solution is to move the nozzle by a specific offset in the Z-axis direction and extrude a kind of half-layer, see right side of Figure 1.

Fig 1 below shows an example of parallel ironing by extrusion to the void on the same Z-height (left) and at an offset forming a half-layer (right). The nozzle used has an orifice and a flat ironing surface around the orifice.

FIG. 1

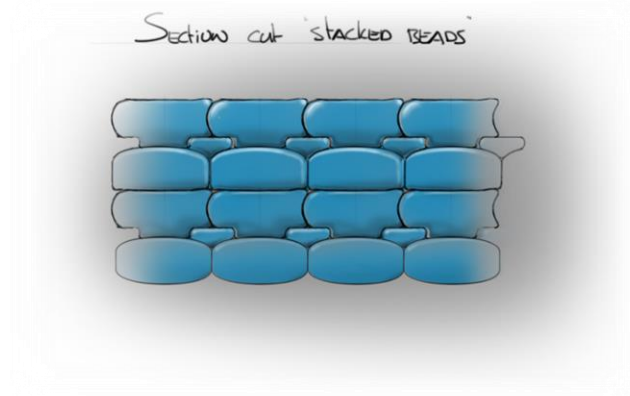


Yet another solution is to extrude enough material in the half-layer so the next layer is pushed up at the time it is extruded. This can be planned so that the half-layer is deposited only every  $n$ -layers.

In Figure 2 an example is sketched where the half-layer is extruded every second layer. In case multiple nozzles are available on the FFF printer, this void-filling strategy by the means of parallel ironing can be performed by a smaller nozzle (e.g. Ultimaker® print core AA 0.25) to increase the extrusion accuracy. In this case, not only the same materials but also different compatible ones can be used (for example PLA at 250°C can be used as super-flowy and sticky filler for ABS).

Figure 2 shows an example wherein the half-layer beads push the following layer up closing the voids for  $n$ -next layers. The half-layer is then extruded after specific number on consecutive layers without it.

FIG. 2



It is noted that the described method can be used with all sorts of printing materials, such as PLA, PC, ABS, PVA , Nylon, etcetera. It is further noted that the examples shown are very simple examples.