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FFF Printing of Dual Material Molds

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Title: FFF Printing of Dual Material Molds

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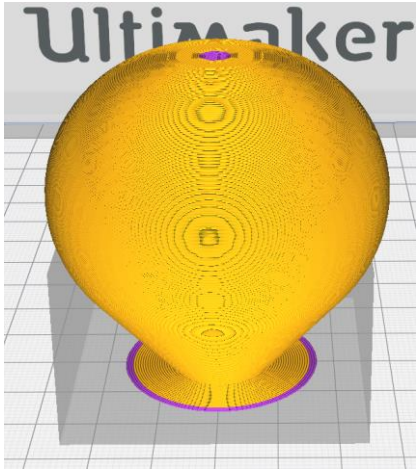
Abstract: A new method for investment casting using additive manufacturing (AM) is proposed. The method can be performed using an FFF printing device having dual nozzles. One of the nozzle deposits a first material while the second nozzle prints a second material different from the first material. Both materials are used to create molds for casting so as to manufacture an end product. The proposed method allows for printing of complex mold geometries.

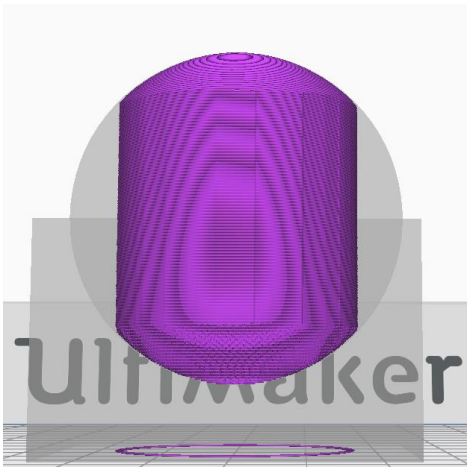
Investment casting using FFF (fused filament fabrication) printers is known. First a mold is printed using FFF, and then the mold is filled with a molten and/or curable material. Once the material in the mold is cured or solidified, the mold is removed by e.g. tearing away the mold, burning the mold, solving the mold in a solvent, or any other way used within the investment casting field.

We now propose to use two different materials to print the mold, also referred to as dual cast printing. The two materials are soluble but in different solvents. By combining materials with different solvability, more complex objects can be made. The dual cast material or dual cast-print material combinations allow for the creation of ‘devices’. Allowing thermosets to be combined with other thermosets or with thermoplastics opens a wide range of properties within the complex design.

It is known that FFF printing with soluble support materials, such as PVA, allows for a higher design freedom. This also accounts for FFF printing of molds. But in case the molds themselves are printed using a soluble material, the support structures, arranged to support parts of the mold, cannot be dissolved with the same solvent as the molds.

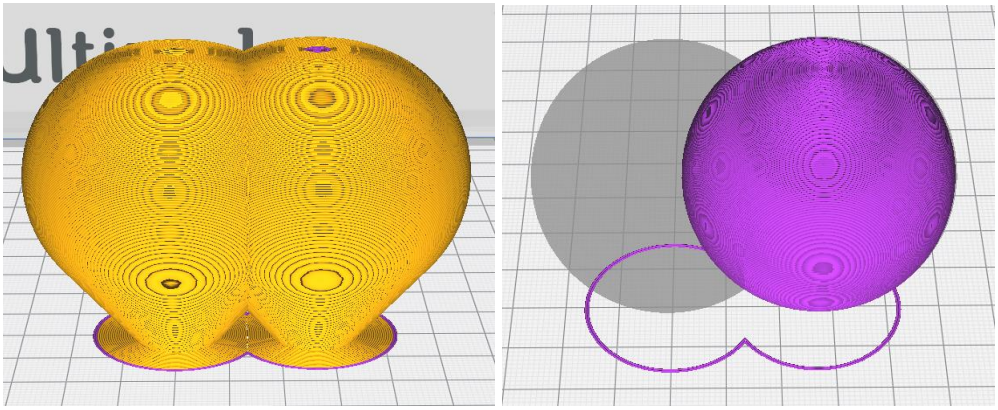
Below a first example is shown of a mold (orange) and an internal support structure (purple). The mold has a spherical inner surface and the support structure is a cylindrical compact object inside the spherical (orange) mold. The support structure is soluble in solvent-A, and the mold itself is soluble in a solvent-B. It is noted that the mold material is not soluble in solvent-A.



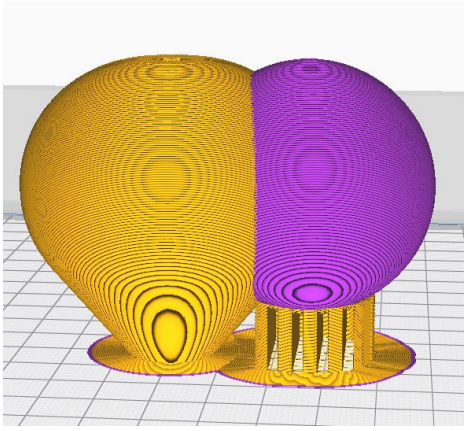


After finishing the FFF printing of the dual material mold, the mold is post-processed by placing the whole mold in a bath with solvent-A. This will remove the support structure but will keep the rest of the mold (i.e. the orange part) in shape. The remaining mold will then be completely hollow, and can then be filled with a molten or curable material. Once solidified or cured, the casted object can be freed from its casting by placing it in a batch with solvent-B. In this case, the end result will be a perfectly spherical object made by means of FFF dual material cast printing.

Now a second example will be discussed. A solvent-A soluble buffer structures (purple) is printed inside a solvent-B soluble Mold (orange). The mold material is not soluble in solvent-A. As with the first example, this allows for casting in two steps (Cast material X, dissolve the buffer structures, cast material Y, dissolve the mold).



It is also possible to print a non-soluble material in combination with the mold (inside or through the mold). This allows for embedding printing material in the final product. See example below.



It is noted that the described method can be used with all sorts of printing materials. It is further noted that the examples shown are very simple examples. Other more complex configurations are conceivable where two materials, or even more materials are used.