

Development of Ceramic 3D Printer Using Cold-Based Extrusion

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Overview

- A ceramic additive manufacturing device was developed for use in the Plasma Electrodynamics Research Laboratory (PERL) in the Johnson Research Center.
- The 3D printer utilizes a cold-based extrusion technique that does not require heating of the ceramic paste during the extruding process.

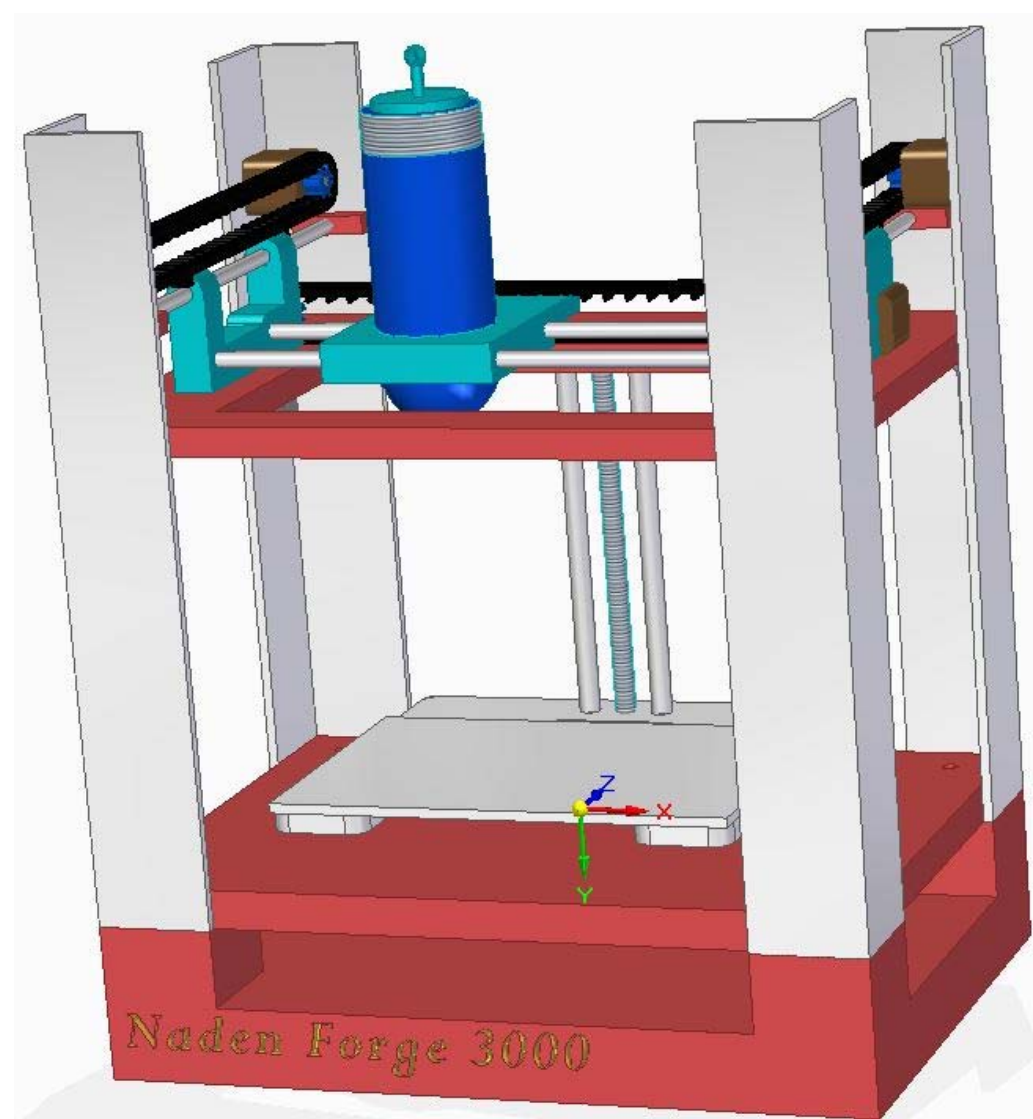


Figure 1- CAD Model of Ceramic 3D Printer

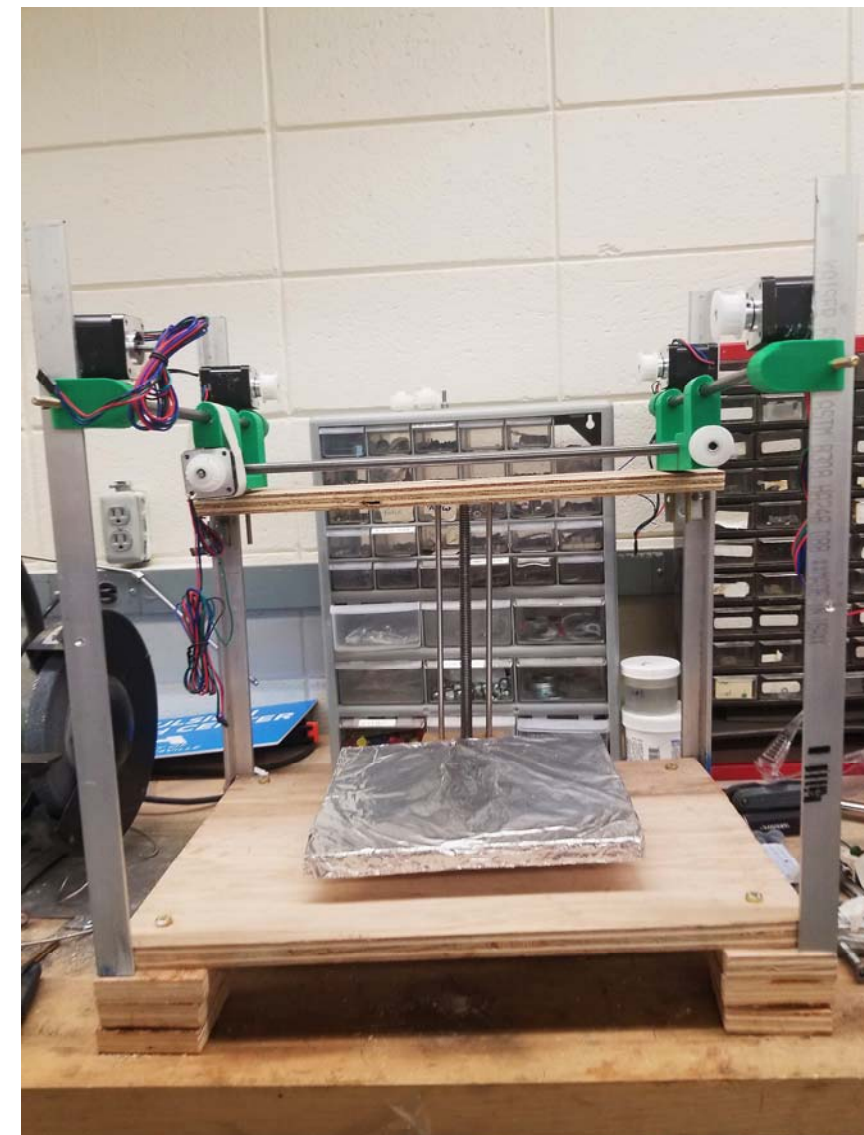


Figure 2- Nearly finished Prototype Ceramic 3D Printer

Impact

- With this ceramic 3D printer, the PERL will be able to quickly and easily create ceramic channel plates for cylindrical hall thruster research. This will allow for novel channel plates to be produced and tested to further our understanding of electric propulsion.



Figure 3- Ceramic pieces were fired in a Cone Art BX119D kiln at cone 8 (about 1250° C)

Key Results

- Mixtures of Calcium Bentonite, Kaolin Powder, and Potash Feldspar were mixed in mole ratios to determine the different properties that may develop.
- Produced ceramics were tested for heat resistance by holding a 3600° F blowtorch against sintered pieces for 30 seconds. No deformation was observed for the following ratios of Kaolin Powder, Feldspar, and Calcium Bentonite in that order: 1:1:0.1, 1:1:0.2, 1:1:0.3, 1:2:0.1, and 1:1:0.5.
- For the above mixtures, it was determined that cones 5-8 with temperature non-constant are suitable for sintering the porcelain bodies.



Figure 4- Porcelain pieces were crafted using a syringe to simulate how the paste would behave when driven by a small piston.

Conceptual Framework

- By understanding the properties of the different mixture powders, mixtures can be tailored to have differing properties such as heat resistance, strength, and the amount of water used as a binder.
- The cold-based extrusion technique simplifies the design of the printer, allowing one to not have to worry about heating the nozzle during the build process.

Acknowledgements

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