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3D Printing and Recycling of Smart Composites

Alexander Olson (UWM)
Dr. Chiu Tai Law (UWM)
Dr. Rani Elhajjar (UWM)

Why?

Terfenol-D — a giant magnetostrictive alloy of Terbium, Dysprosium, and Iron — has had little advancement in the way of composite manufacturing. The intent of the project is to integrate Terfenol-D into acrylonitrile butadiene styrene (ABS) to form a "smart composite." This smart composite would be extruded into filament used in 3D printing, and objects produced using this filament would exhibit magnetostrictive properties.

What is "Magnetostriction?"

Magnetostriction is the ability of a material to expand or contract in the presence of a magnetic field. This property can be used to convert between electromagnetic energy and mechanical energy in either direction.

Important Applications

PROTOTYPING

Prototyping is the most obvious application of 3D printing. While it isn't always cost effective to produce with this method on large scales, 3D printing has a huge advantage over other methods regarding the quick production of prototypes. Bringing Terfenol-D into the realm of 3D printing will allow for the rapid expansion of its own uses.

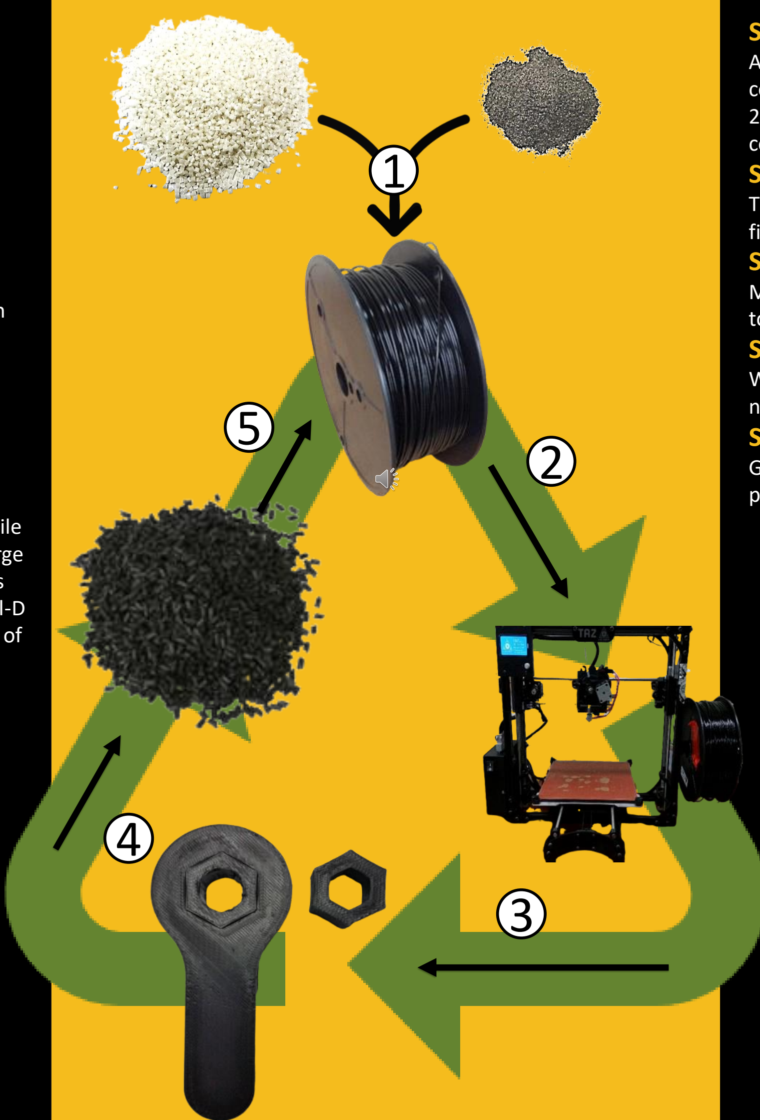
SPACE EXPLORATION

In space, 3D printing is the only feasible way to manufacture a tool or part, as the other options take up too much invaluable space and weight. With the methods laid out in this project, Terfenol-D composite parts can be manufactured all but immediately in space stations, or on deep space ventures, and help further our reach in space. Even more importantly, these parts can be recycled into more composite material, which can in-turn be made into more parts or tools.

CONTACT INFORMATION

Alexander Paul Olson – olsonap@uwm.edu
Dr. Chiu Tai Law – lawc@uwm.edu
Dr. Rani Elhajjar – elhajjar@uwm.edu

COMBINE, PRINT, RECYCLE, REPEAT



ACKNOWLEDGEMENTS

My wife, Rebekah, and my daughters, Rosalie and Daisy.

How?

STEP 1

A 2:5 ratio by mass of Terfenol-D powder to ABS plastic is combined in the filament extruder at a temperature of 200-210° C. Filament is carefully wound onto a spool under constant tension to ensure uniform thickness.

STEP 2

The 3D printer is calibrated to the new magnetostrictive filament and will extrude at approximately 230-240° C.

STEP 3

Magnetostrictive parts, tools, sensors, etc. can be 3D printed to exhibit magnetostrictive properties.

STEP 4

When the product has served its purpose and new filament is needed, the product can be broken down into granules.

STEP 5

Granules are re-extruded at a temperature of 200-210° C to produce recycled filament.

To what extent?

In order to responsibly reuse this composite, it is necessary to determine how many times a sample can be recycled before loss of structural integrity.

To determine this, one sample will be recycled repeatedly until it reaches a point of unacceptability. After each cycle, the sample will be evaluated mechanically via tensile, torsion, and compression tests, as well as chemically, via Fourier-transform infrared spectroscopy (FTIR). These tests will help determine the reliability of using recycled material for different purposes.

Example: Tool A requires virgin composite. Tool B can use composite which has been recycled up to 6 times.