# Machinery

# Three-dimensional printing of continuous-fiber composites

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## Purpose of Research

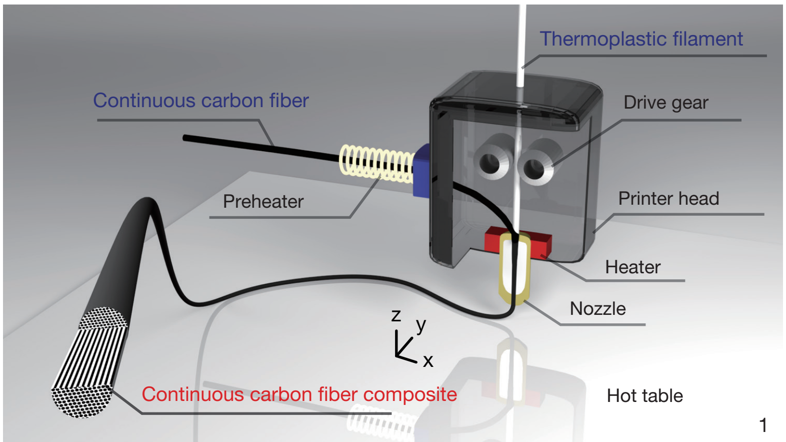
Three-dimensional (3D) printers that use resin are now available on the market. It is well known that they easily form simple and complicated 3D objects without using molds or jigs. However, they can only produce structures that are too low in strength to be used as high-quality components for industrial products. This research uses continuous fiber-reinforced resin composite materials to develop 3D printers that can make high-strength and high-rigidity products that support people's lifestyles, such as structural members of automobiles and aerospace equipment as well as medical and welfare equipment.

## Summary of Research

This technology not only enables single-stroke drawing using continuous carbon fiber composites, but also controls the directions of fibers and the fiber content in local regions of an object in accordance with how it will be used. It also computes and proposes optimal material conditions, leading to new product structures and usages.

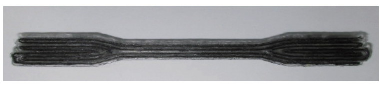
### High-strength 3D shape forming with a continuous carbon fiber 3D printer

• A printing nozzle blends continuous carbon fiber with thermoplastic resin.

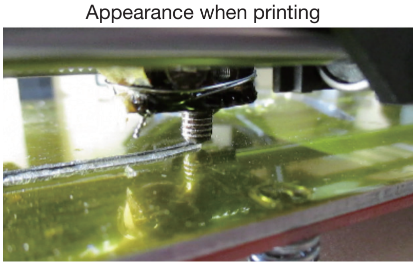



1

Test piece



Appearance when printing



## Comparison with Conventional or Competitive Technologies

- Using continuous carbon fiber dramatically improved the tensile strength and rigidity of a structure compared with commercially available industrial use 3D printers (powder sintering, photo-fabrication, and fused deposition modeling).
- Using thermoplastic resin significantly reduced production cost and lead-time compared with conventional thermosetting CFRP.

## Expected Applications

- Structural members of automobiles and aerospace equipment
- Medical equipment and welfare equipment such as rehabilitation assist devices
- Sports gear and recreational facilities

## Challenges in Implementation

We have already developed elemental technologies such as continuous carbon fiber 3D printing, fiber cutting, and optimization of fiber orientation. To put the technology into practice, we will increase the volume content of fiber to the level equivalent to that of conventional CFRP products.

## What We Expect from Companies

This technology is useful for companies that need to manufacture a large variety of high-strength components in small lots. We would like to conduct joint R&D activities with companies that have the technologies to manufacture finished devices or those who plan to expand their business into the 3D printer field. We would also appreciate the support needed to start a venture firm.

**Points**

- **Lightweight, high strength, and high rigidity**
- **Controlling the orientation and content of reinforcing fiber**
- **Significant reduction in production cost by on-the-spot impregnation of fiber into thermoplastic resin**

## Future developments

August 2016: Finalize the specifications of a large prototype.

March 2017: Complete assembly of the prototype.

April 2017−: Exhibit the prototype at an event and ship samples.

(Plan to develop a small-type concurrently.)

■Associated System: Strategic Core Technology Advancement Program (Supporting Industry Program)
: NEDO Project, Next Generation Structural Material Creation −Development of Processing Technology
■Associated Institutions:
Tokyo Institute of Technology, Nihon University, JAXA, and others
■Intellectual Property: PCT/JP2015/65300, and others
■URL of This Project: http://www.rs.tus.ac.jp/composites2/