3DプリンタによるComposites 2.0のプリント成形

Manufacturing of Composites 2.0 by means of 3D printer

- Composite obtained by DDM is referred to Composite 2.0, and those obtained by conventional manufacturing as Composite 1.0.

- A fiber reinforced plastic obtained by Composites 2.0 technology is a fully structurally and functionally optimized material with the fiber direction and volume fraction precisely controlled at every location in the composite materials with inclusion of various structural materials.
Background

**DDM of 3D printed composites: Composite 2.0**

- Fully structurally and functionally optimized CFRTP component.
  1. Optimization of fiber direction \(\leftrightarrow\) Stacking sequence optimization
  2. Optimization of fiber volume fraction (0 to 60% volume fraction)
  3. Combination of several fiber and matrix
  4. Implementation of functional materials

- Relaxation of stress concentration
- Debonding free sandwich structure
- Stiffness tailoring

- This paper proposes

Additive manufacturing of continuous carbon fiber reinforced plastic by *in-site impregnation technique*

*A thermoplastic polymer and continuous fibers were separately supplied to a 3D printer.*
Fused deposition modeling by means of in-site impregnation technique

- Commercially available 3D printer (Fused deposition modeling) was used.
- Printer head was modified to supply a continuous carbon fiber.

A thermoplastic polymer and continuous fibers were separately supplied to a 3D printer. → *In-nozzle impregnation of fiber with matrix*

- Fiber and matrix can be selected arbitrarily.
- Fiber volume fractional can be changed.
- Several fibers and matrix can be hybridized.

**Thermoplastic filament** (PLA, φ1.75mm)

**Carbon fiber** (T800S, Toray)

≈ 100 fibers

Fig. 1 Schematic diagram of the printer head
Fig. Our first 3D printer for continuous fiber composites by in-nozzle impregnation
Materials

- **Condition of printing**
  
  Nozzle temperature : 210 °C
  Heated bed temperature : 80 °C
  Printer-head moving speed : 100 mm/min
  Feeding speed : 100 mm/min
  Diameter of injection nozzle: 1.4 mm

Fig. 2 Condition of 3D printing

Movie of 3D printing of a unidirectional CFRTP
Specimens

- **3D printed tensile specimen**
  - Unidirectionally CFRTP.
  - Fiber volume fraction of CFRTP specimen was $\approx 6.6\%$
  - PLA specimen, Jute fiber reinforced plastic (Green composite) was also printed by the 3D printer.

- **Tensile test**
  - Universal testing machine
  - Loading speed: 1.0 mm/min