November 27, 2015

第１回　繊維強化プラスチック成形のための3Dプリンターに関するワークショップ

First Workshop on Composites 2.0

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.

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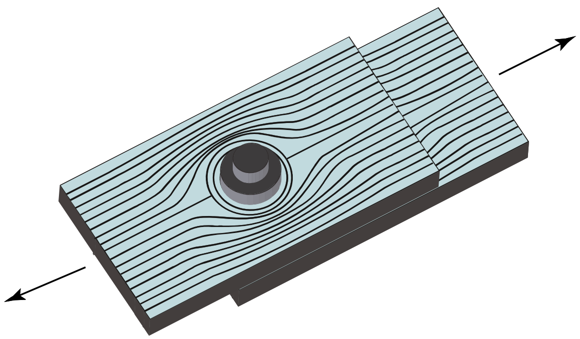
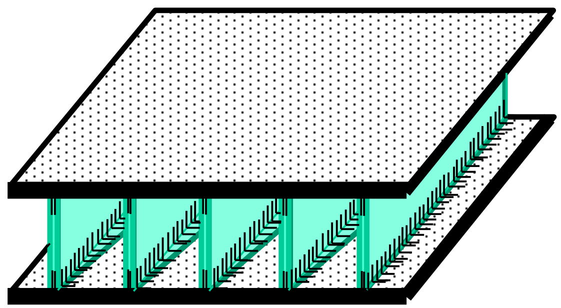
DDM of 3D printed composites : ***Composite 2.0***

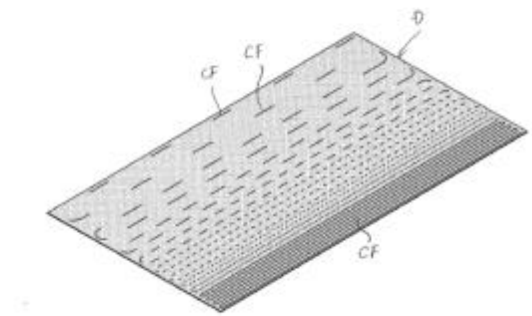
- Fully structurally and functionally optimized CFRTP component.
  - (1) Optimization of fiber direction ← ~~Stacking sequence optimization~~
  - (2) Optimization of fiber volume fraction (0 to 60% volume fraction)
  - (3) Combination of several fiber and matrix
  - (4) Implementation of functional materials



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

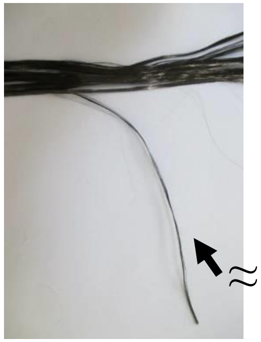
- Commercially available 3D printer (Fused deposition modeling) was used.
- Printer head was modified to supply a continuous carbon fiber.

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)



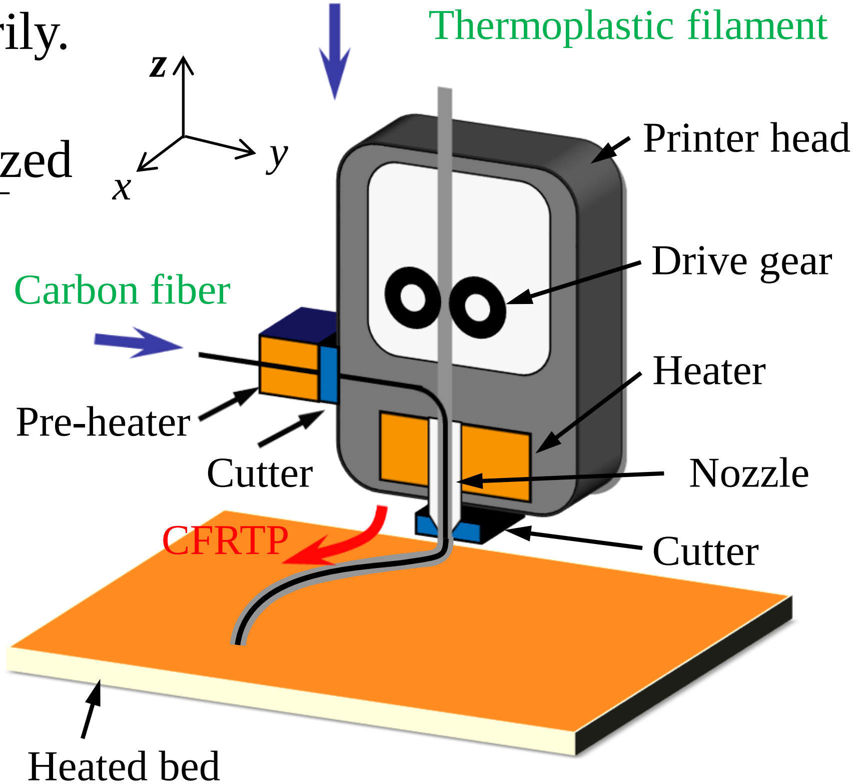


Fig. 1 Schematic diagram of the printer head

3D printer for continuous fiber composites

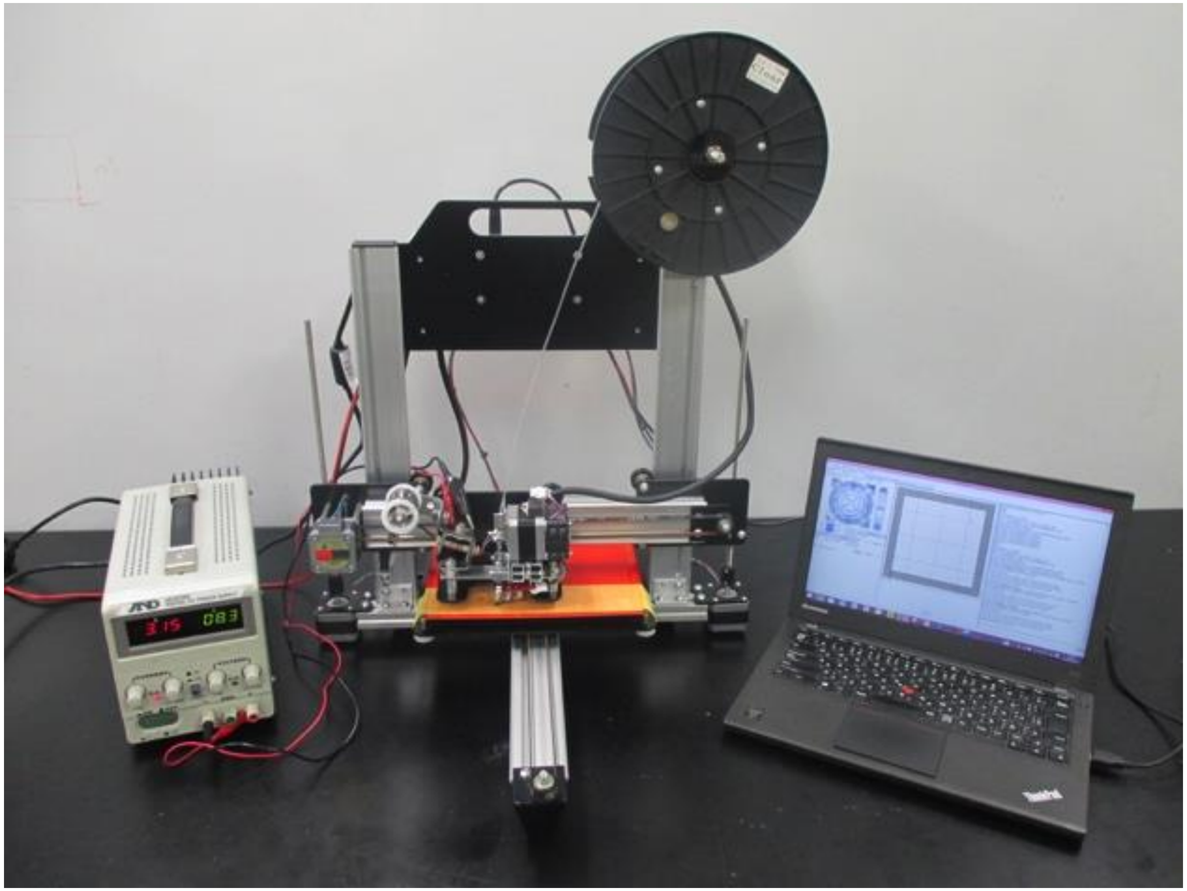


Fig. Our first 3D printer for continuous fiber composites by in-nozzle impregnation

- *Condition of printing*

Nozzle temperature	:	210 ºC
Heated bed temperature	:	80 ºC
Printer-head moving speed	:	100 mm/min
Feeding speed	:	100 mm/min
Diameter of injection nozzle	:	1.4 mm

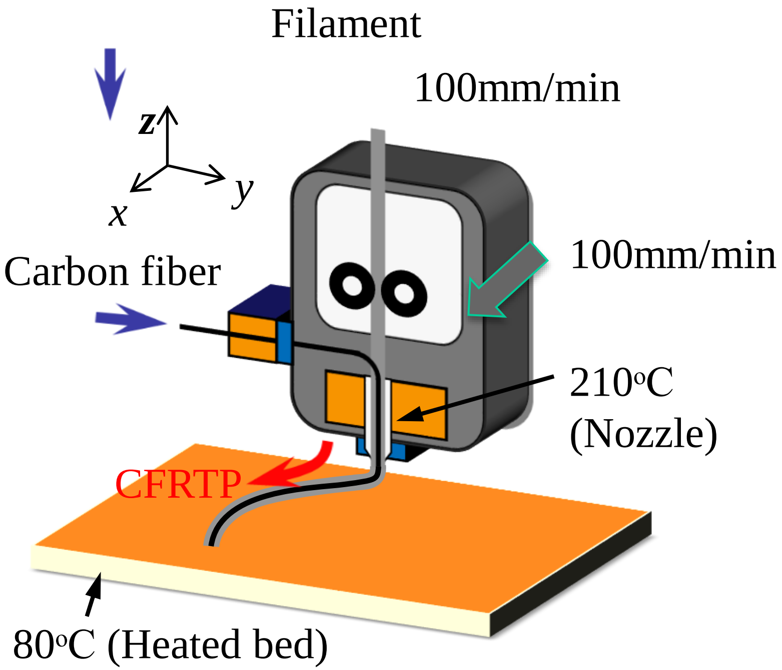
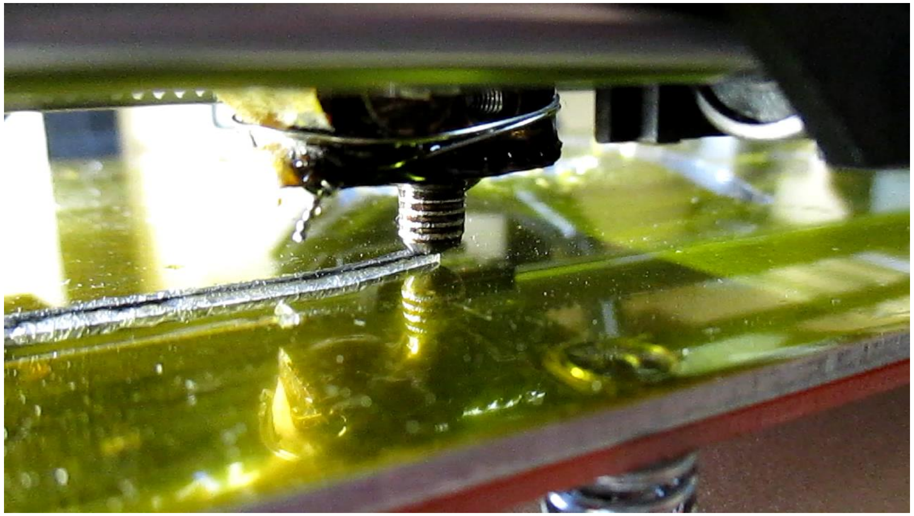


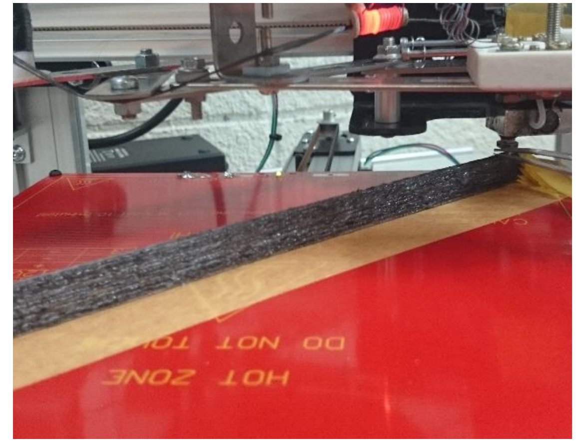
Fig. 2 Condition of 3D printing

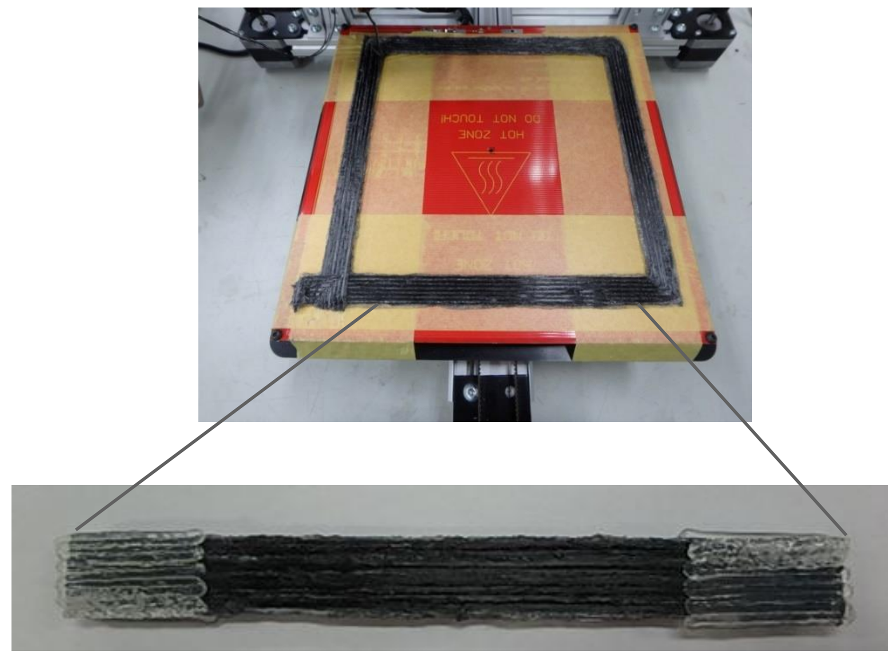
Movie of 3D printing of a unidirectional CFRTP



Specimens

- *3D printed tensile specimen*
  - Unidirectionally CFRTP.
  - Fiber volume fraction of CFRTP specimen was ≈ 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