Riga Technical University (RTU)

TEHART 3D,

Printer head for hybrid filament yarn

Invention:
3D printer pultrusion head compatible with Twintex® or any other Co-Mingled glass and thermoplastic reinforcements yarns acting as a filament.

Applications:
FFF based additive manufacturing technology for cost efficient stiffness/strength facilitated parts

TRL: 6
Assembly compatible with cartesian and delta FFF printers as well as CNC type of routers. Assembled on a robotic arm.

IP status:
Pending PCT patent application, no. PCT/IB2020/053528.

IP valuation:
Cost-based assessment, effective negotiations.

Researcher team:
Dr.Kaspars Kalniņš
M. Kristofers Celms
Juris Kļava

Historic milestones:
2017: Proof of concept
2018: First printed specimens
2020: Invention established.
2019-2021: technology validation

Research timeline:
29.01.2018.- 30.09.2021, funded by ERDF, 1.2.1.2. "Support for the improvement of the technology transfer system"

Technology transfer:
Licence or patent sell to the industry.

Contact information
Kaspars Kalniņš,
Technology Innovation Lead
kaspars.kalnins@rtu.lv
+371 26 75 16 14

Riga Technical University
Registration no: 3341000709
VAT registration no:
LV-90000068977
Kaļķu iela -1,
Riga, LV-1658
www.rtu.lv

Market challenge
In order to achieve the promise FFF bear of part performance the printing filaments material costs skyrockets. At the same time mechanical performance only mildly increases with short fibre reinforcement as carbon etc. FFF high performance (UltemTM CF – roughtly 750 eur/kg or FibreX™ PEEK GF20 - roughtly 650 eur/kg) filament street price range easily reaches above hundreds of euros giving a market entry barrier for market uptake and scalability. While raw co-mingled yarns widely available in traditional textile industries are left waiting to be incorporated in FFF processes even though the benefits are obvious - performance, cost and scalability required by industrial uptake.

The invention
Developed patent pending (PCT/IB2020/053528) 3D print head is a cornerstone of given technology. Invention is modular in order to ease its integration in various 3D printers, robots and gantry systems. However, slight modifications (e.g. mounting adapter plates, electrical connections, firmware or EEPROM configuration changes, etc.) might need to be performed depending on host system configuration. Currently, the 3D printhead has been implemented and tested in multiple Mass Portal 3D printers, as well as in Ender series, and a modification has been made to adapt a custom Isel CNC machine and Kuka robotic arm.

3D printing from co-mingled yarns
Polymers yarns for textile industries are in range of 2-4 euros per kg while glass fibre is even less below 1 eur/kg. Co-mingling is matter of cents per km, thus cost efficiency is by a magnitude compared to traditional FFF filaments. Worldwide availability and multi-vendor supply chain bear promise for industrial uptake. An example Twintex® has been proven to be fully compatible with invented printer head tested on MassPortal and Ender systems.

Technology specification
Proposed technology is based on pultrusion principles, where co-mingled polymer part of the yarn is melted in a heat chamber and then laminated with advanced fiver as glass our carbon in a layer-by-layer manner. The continuous filament is provided from industrial spools without limiting they net volume for production. Co-mingled yarns with linear density up to 2500 g/km has been proved to be printable with current pultrusion method. Were large linear (2000 tex) density filaments secure rough finish however rapid production timings. Additional cooling/pressure plate has been added to printer head to secure adhesion strength and constant layer thickness. It has been found that object exceeding 100 x 100 x 100 are most efficient to produce by stated printer head and technology.

Co-mingled polymer dictates melting thus production speed. It should be noted that for certain co-mingled polymer yarns a requirement should be tailored for moisture/plate heat and final heat dissipation from printed object.

A continuity in a printing file should be enforced where each layer starts were other ends, thus the objects of rotation are best suited for particular printing method.

Physical characteristics

- Layer height 200 – 1200 µm;
- Linear density 500 - 2000 tex;
- Flowrate 180 – 1800 mm^3/min;
- Nozzle size 0.8 – 5 mm;
- Stainless steel alloy heatbreak;
- Brass or stainless steel nozzle;
- Temperature range 180 – 300 °C;
- Higher than 150 overhang slope.

Functional characteristics

- Proportional to filament layer bend radius;
- Modular design;
- Compatible and tested with multiple 3D FFF systems · Variable additional thermoplastic proportion adjustment with Bowden extruders;
- Omni-directional yarn feed into printhead.

Technology characteristics:
- Multi-vendor and world-wide availability of raw materials;
- Modular design enables rapid implementation into existing 3D additive systems;
- Compatible with wide variety of co-mingled thermoplastic yarns;
- Cost efficient technology for high tensile-strength augmentation applications.