Continuous Directed Laser Preheating of Big Area Additive Manufacturing

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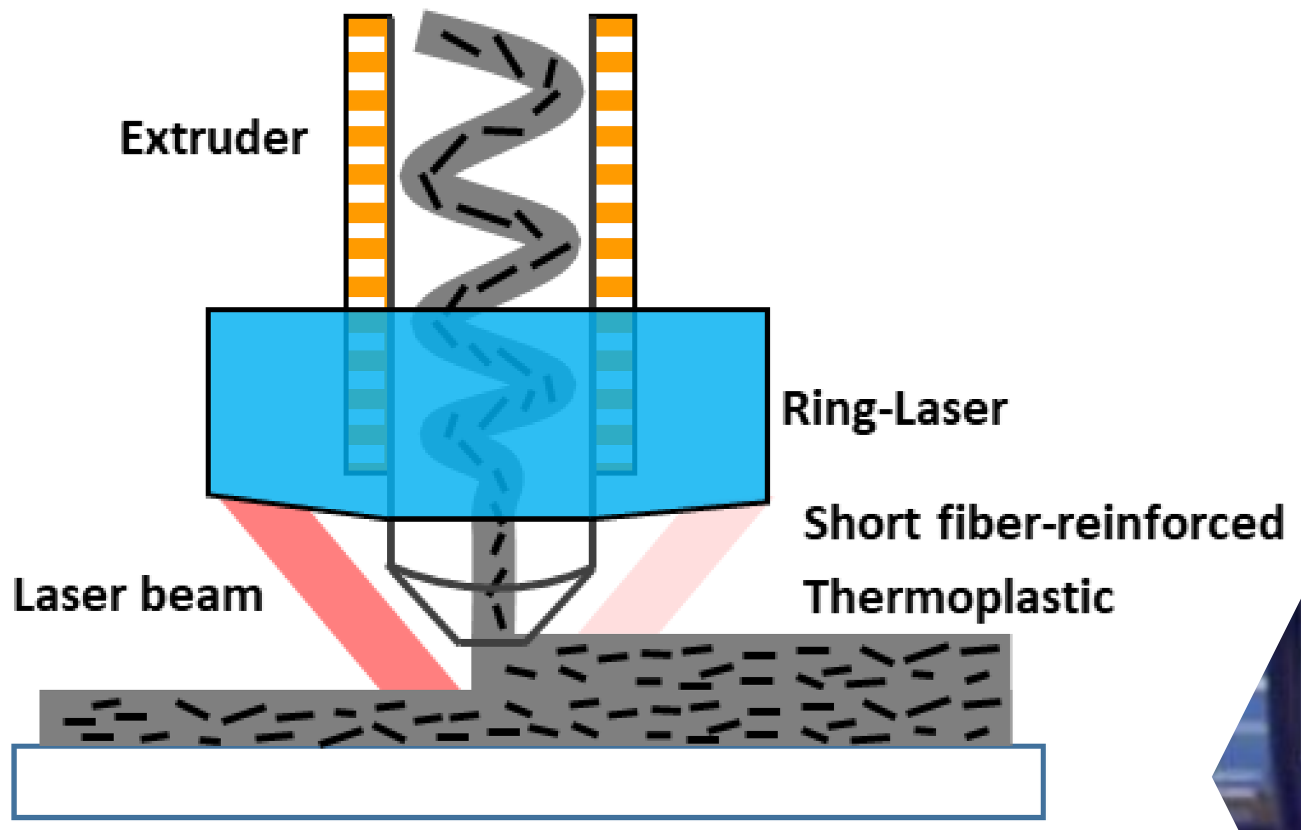
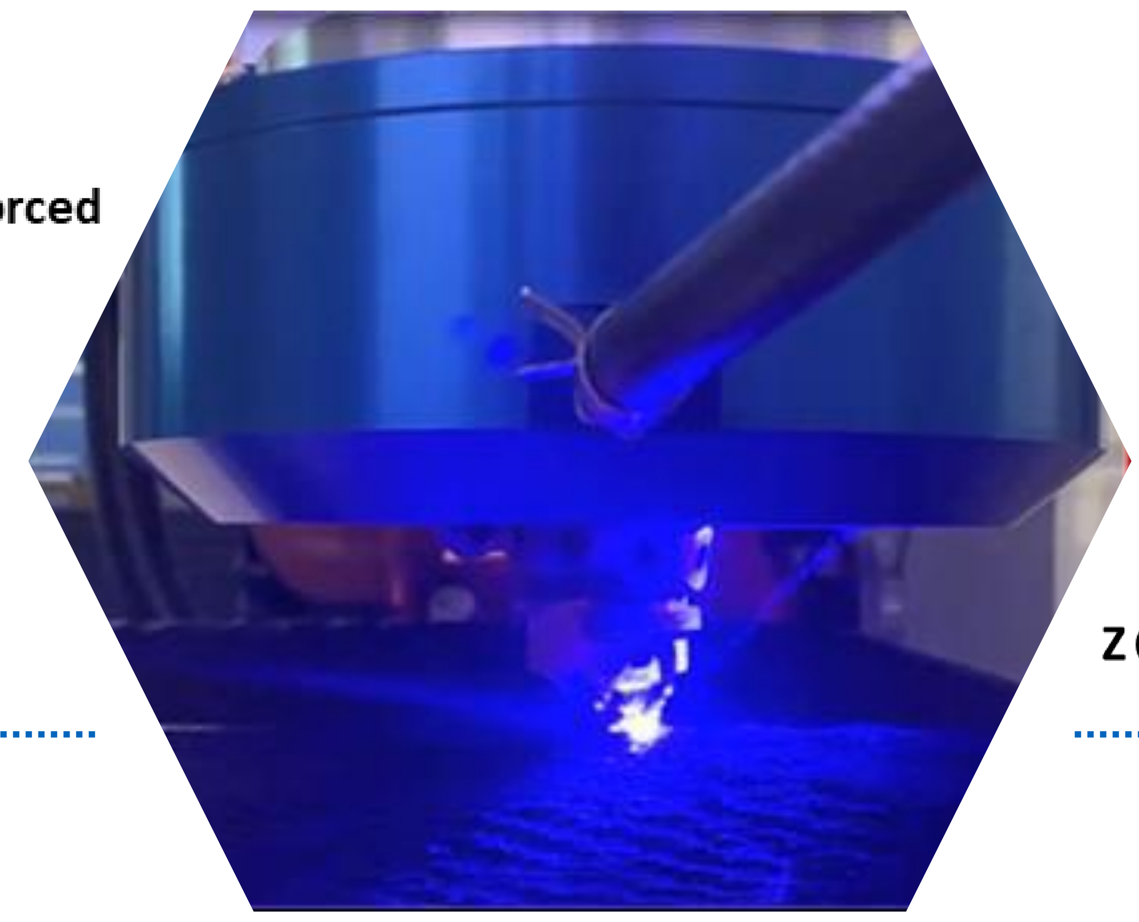
Introduction

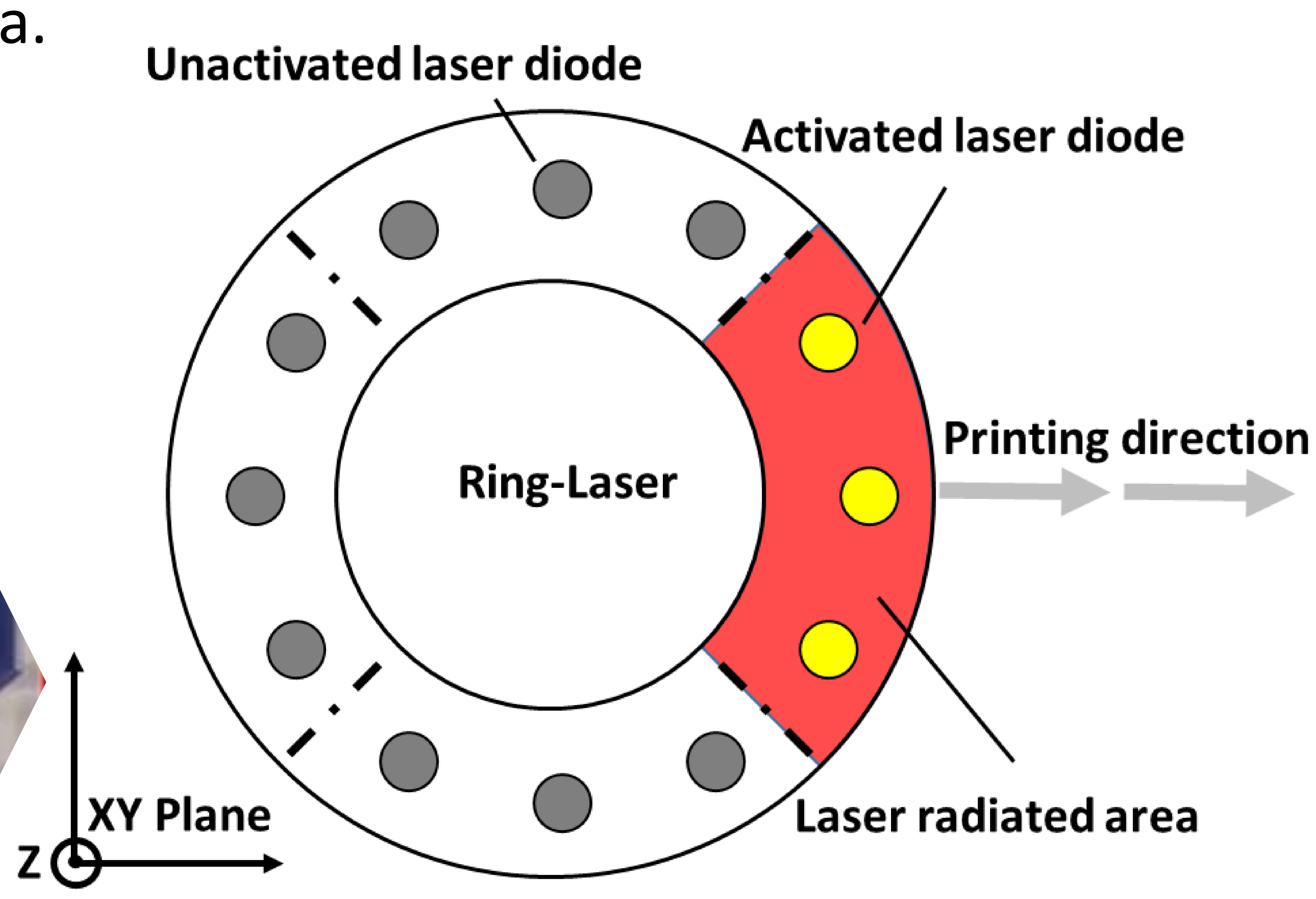
In big-area additive manufacturing (BAAM) or large-format additive manufacturing (LFAM), one of the crucial factors that affects greatly the interlayer bonding strength is the substrate temperature during the printing process. By using laser heating of the substrate, the interlayer bonding strength can be improved without much impact on the printing process. However, due to the high processing speed and frequent changes in the printing direction during the printing process, heating the substrate only with only one or two heating sources in a fixed location is not sufficient to meet the requirement of the complex printing process, such as printing on curves or circles.



Method

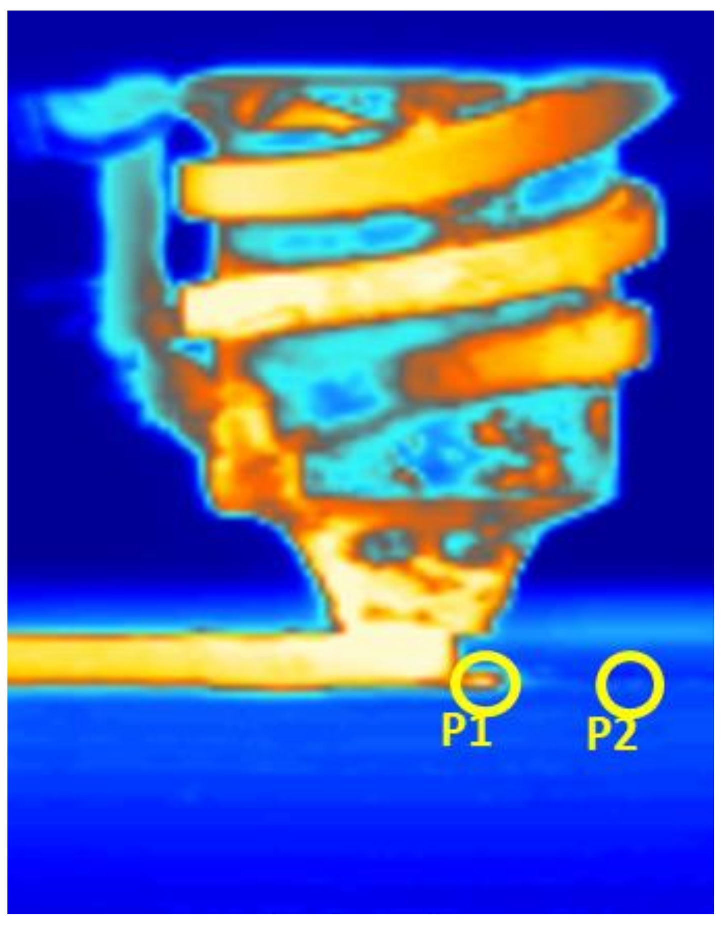
We have proposed a method of using an active laser heating system with multiple heating sources to heat up the substrate continuously. The laser heating system has multiple control channels, which are used to control the state and the power of the laser diodes. The heating area is divided into multiple sections, which are activated according to the current printing direction. With this approach, the substrate can be heated along the printing path without stopping. It is especially essential when printing a circle or a long curve path, which requires the adjustment of the heating area continuously during the process. The printing direction is transmitted from the robot controller to the controller of the laser heating system at a high frequency, which can achieve real-time modifications of the laser diodes and changes in the heating area.





Result

The temperature of the substrate heated by different laser power with the same printing speed (30 mm/s) is measured. The used laser power changed from 0 W to 30 W and is radiated on a 6 mm*2 mm area. Without laser heating, the temperature of the substrate is about 100 °C. With full power at 30 W, the temperature of the substrate is above 300 °C.



The interlayer bonding performance is represented by the result of the three-point bending test. By using the laser power at 50% (15 W), the reached highest flexural strength is about 86 Mpa, which is 137% more than that of the specimens without laser preheating. Furthermore, the reached flexural strength is about 80% to 90% of the value in the material data sheet, which represents the flexural strength along the fiber direction.