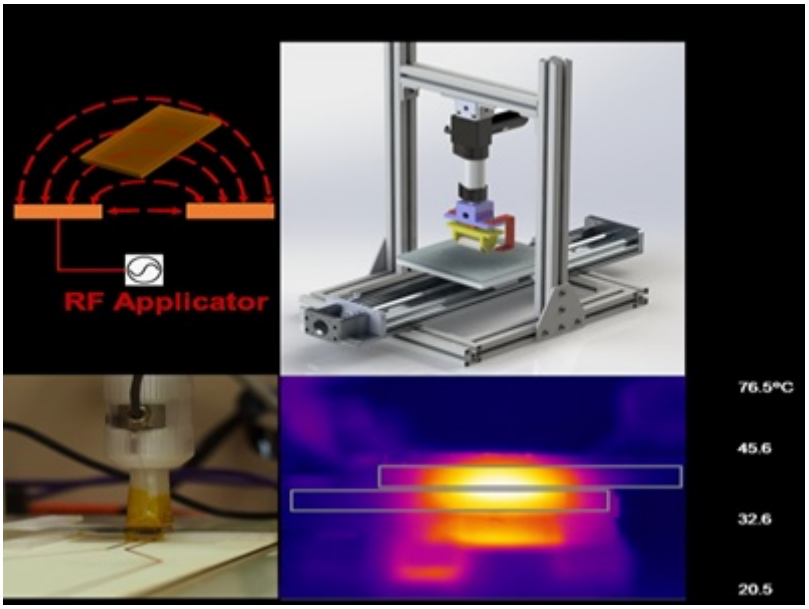
Energy-Efficient Fusion Bonding with RF Heating

Polymers and composites are crucial materials for automotive and aerospace manufacturing but require new methods to weld them to other materials. Through the use of RF heating, energy can be efficiently targeted to heat up the desired weld. The technology uses a closed-loop system with high automation, controlling the heating power through onboard sensor data for consistent welds.



What is the Problem?

Advances in the automotive and aerospace industries have brought into focus the economic and ecological benefits of polymer and composite materials. Therefore, there is a need for optimized manufacturing methods capable of bonding or conjoining parts made from these classes of materials at scale. Mechanical fastening such as screws and bolts not only add weight but would also create points of high stress susceptible to failure. As for welding approaches, existing approaches such as inductive welding or ultrasonic welding prove either unable to scale, or unable to work with complex geometries required for modern vehicle designs.

What is the Solution?

Radio frequency (RF) heating uses high-frequency RF waves to heat carbon materials such as graphite, while leaving all others untouched. The technology coats RF-sensitive graphitic susceptors along the desired weld, which heat up to high temperature upon application of an

Technology ID

BDP 8460

Category

Materials/Composites
Selection of Available Technologies

Authors

Aniruddh Vashisth

Learn more

RF field. This allows the heating energy to be targeted only where it is wanted, and then to safely dissipate into the surrounding material.

The technology takes this concept further and incorporates a closed-loop approach to controlling the RF system during welding. The materials are held together with an applied pressure and monitored by a thermal camera. Feedback from the pressure and temperature sensors are used to control the RF heating system, resulting in consistent welds every time. This approach allows the system to be flexible to working with different materials, while maintaining a high degree of automation.

What is the Competitive Advantage?

This technology takes the recent advancement of RF heating of carbon materials and applies it to a much-needed area in advanced manufacturing. RF heating is an energy-efficient welding method for various polymers and composites, requiring no oven and leaving no artifacts as would be seen in other welding methods. The method was demonstrated to weld samples at a power of only 50 Watts in 2 minutes. This energy efficiency is thanks to the improved penetration depth and selectivity of RF waves, as opposed to commonly used microwaves. Finally, the closed-loop control scheme allows the entire process to be highly automated, and thus scalable for manufacturing purposes.

Patent Information:

WO2023249936

WO2022271633

References

1. Ian Enriquez, Colin Noronha, Katrina Teo, Anubhav Sarmah , Surabhit Gupta , Ankush Nandi, Blake Fishbeck, Micah J. Green, Aniruddh Vashisth(44998) , https://www.mdpi.com/2504-477X/7/3/116, https://www.mdpi.com/journal/jcs, 7, 116
2. Ian Enriquez, Colin Noronha, Katrina Teo, Anubhav Sarmah, Surabhit Gupta, Ankush Nandi, Blake Fishbeck, Micah J. Green, Aniruddh Vashisth(2023-03-13) , https://doi.org/10.3390/jcs7030116, https://www.mdpi.com/journal/jcs, 7, 116