

Recycling of multilayer composite by shock produced by Laser

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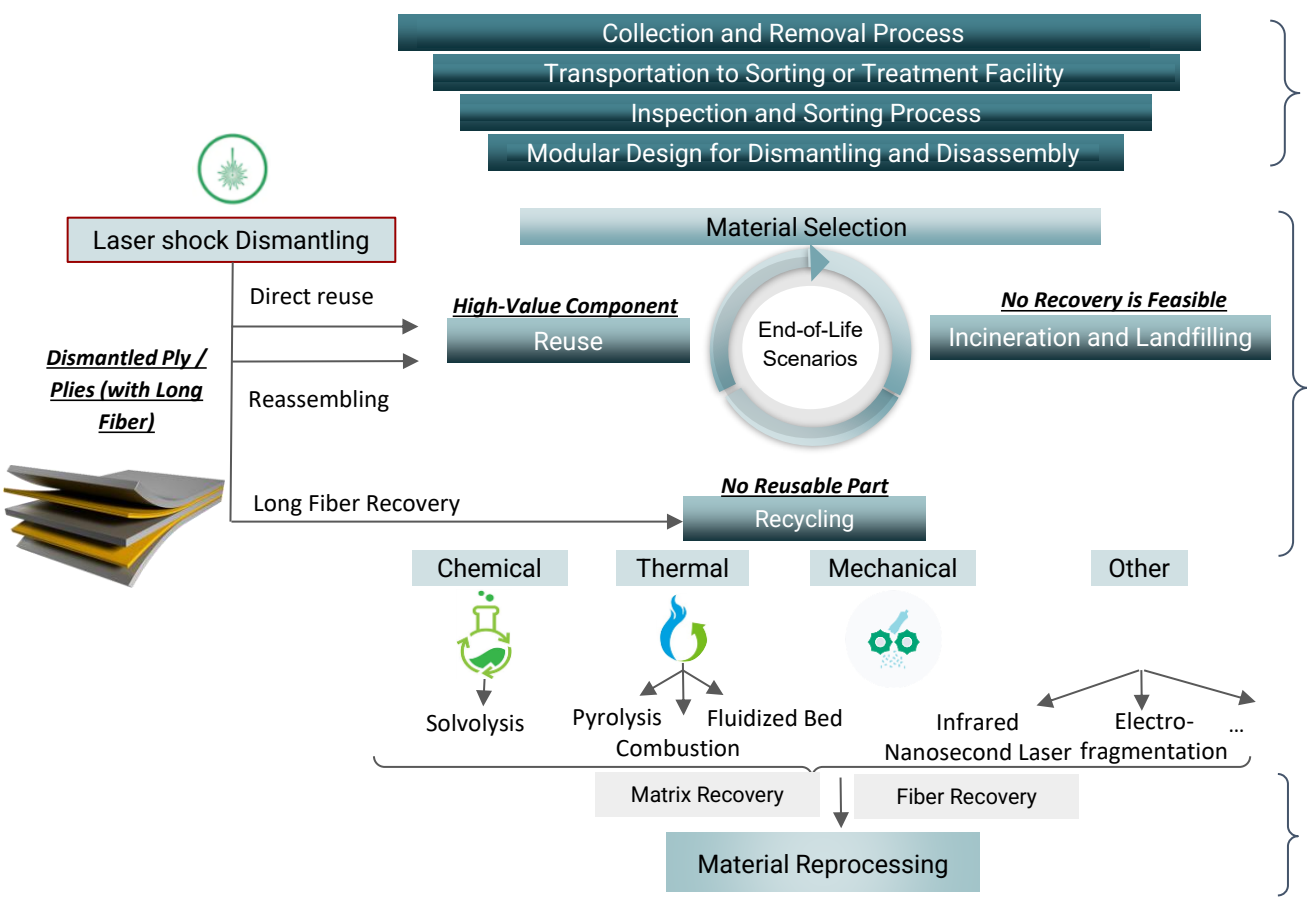
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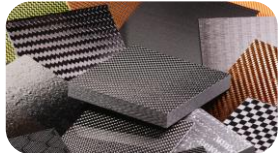
Yann rouchausse (IE CNRS)

<https://www.recreatecomposites.eu/>

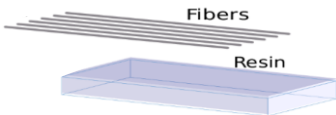
Implementation in Recycling



Macro-scale (Structural scale)



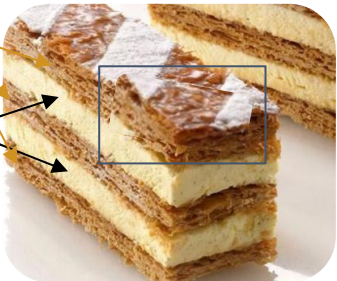
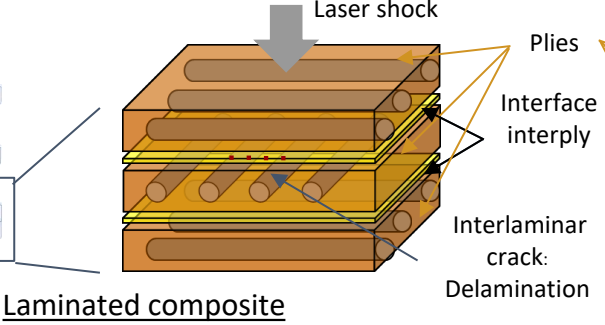
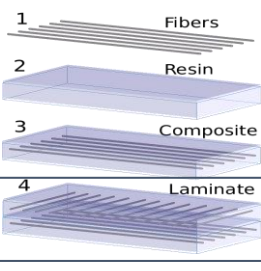
Material scale (Composite material scale)



Micro-scale (fibers, matrix)

Dismantling Laminated Composite Materials

Objective: Make the dismantling process easier to visualize, illustrated with a simple analogy: the mille-feuille pastry



Reference Material: 3 Plies



Separation



3 Separated Plies



Adhesive bonded interface

Reassembled Material: Plies + Adhesive



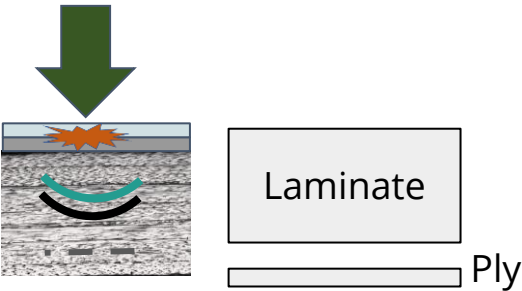
Reassembling in Progress for Reuse

Minimally Invasive and Selective Disassembly using Laser Shock

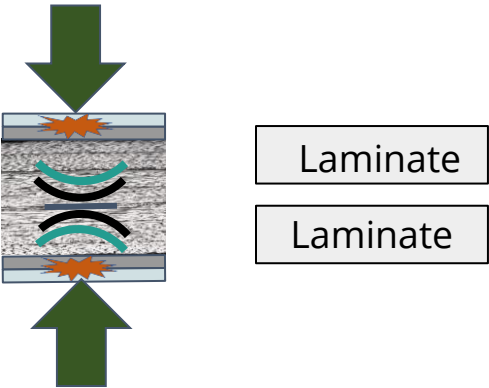
Objective: Present the laser shock principle

Short nanosecond pulses enable micrometer-scale precision, and the versatility of the laser beam allows selective and localized delamination

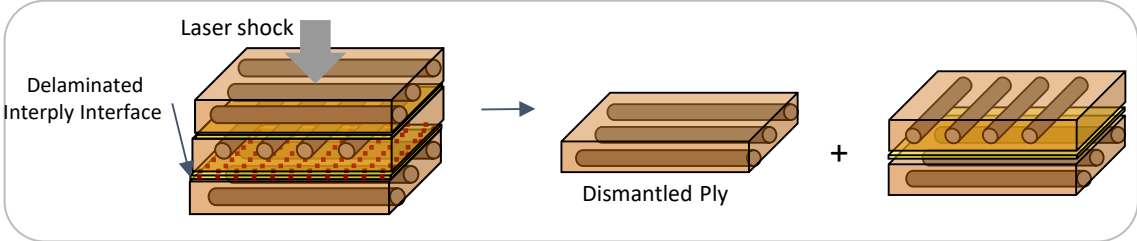
Ply by ply disassembly



Laminate disassembly

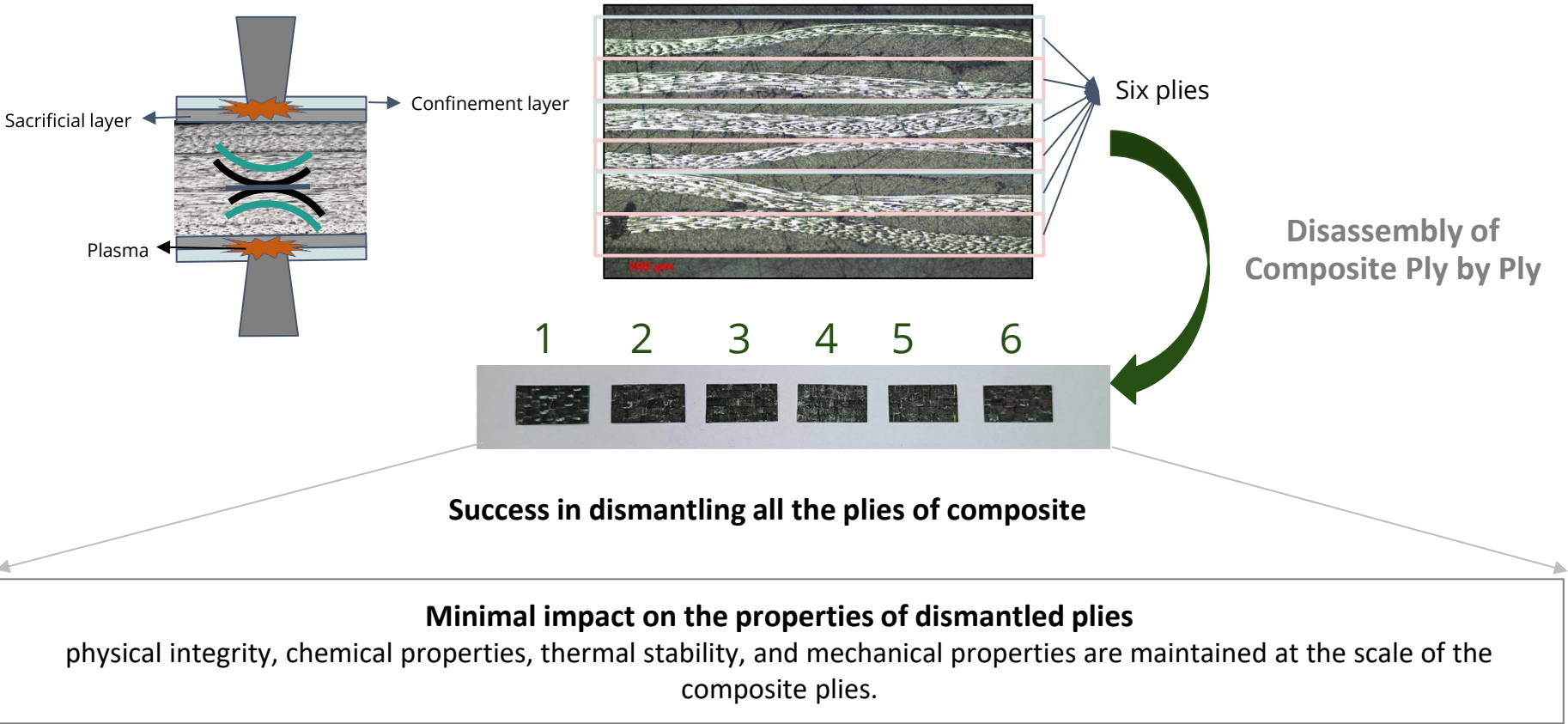


Generates controlled tensile stresses that induce local delamination at the selected inter-ply interface.



Demonstration

Objective: To investigate the ply-by-ply dismantling of laminated composites and assess ply properties for potential reuse.



Reassembled Material after Dismantling: Impact on Reassembled Samples

Objective: Reassemble the dismantled materials and characterize them to assess their potential for reuse.

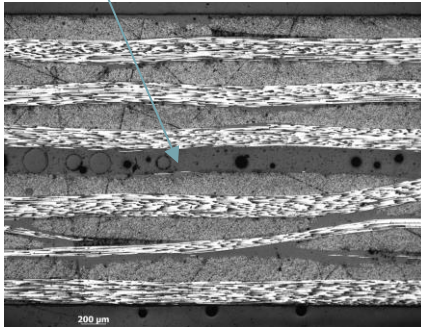


Adhesive

Dismantled: Part 1
1.07 mm

Adhesive 0.13 mm

Dismantled: Part 2
1.06 mm



- Structural epoxy **3M Scotch-Weld EC-9323 B/A**
- Mix: **1.4 g (Part A) + 5.0 g (Part B) + 0.1 g glass microspheres (1 wt% Spheriglass 2429)**
- **0.2 mm microspheres**
- Selected for **good adhesion to CFRP** and **T_g ≈ 100 °C (DSC)**.

Maintaining **100% Flexural Modulus** Through **Dismantling** and **Reassembly** for Reutilization

- ✓ **Effective technique** for dismantling laminated composites, ply by ply
- ✓ **Versatile** technique for all layered composites
- ✓ The process can be applied to **both manufacturing and end-of-life** waste
- ✓ **Non-contact, non-invasive** use of a chemical **product**
- ✓ The recovered plies can be reused in **high-value** applications, with negligible impact on properties after laser shock
- ✓ The **properties are maintained** after **reassembly** of the dismantled plies, validating their reusability
- ✓ The process can be **controlled** using SHM (Structural Health Monitoring)



The laser shock process for laminated composite dismantling is ready for industrial implementation

Thank you for your attention

Publications

Ines Sma, J.P. Márquez Costa, E. Richaud, Y. Rouchausse, E. Sarlin, F. Wunderle, L. Berthe
“Can Laser Shock Effectively Dismantle Carbon Fiber Laminated Composites While Preserving Material Integrity for Reuse?”
Composites Part A, 2025.

Ines Sma, S. Ünalı, M. Ayad, M. Gervais, L. Berthe, E. Richaud
“Laser Shock Adhesion Testing of Thermally Aged Epoxy Coatings”
Progress in Organic Coatings, 2024.

Publication in progress

I. Sma, M. Rébillat, T. Novellino Patricio, E. Dubois, Y. Rouchausse, F. Letellier, E. Richaud, J.-P. M. Costa, N. Mechbal, L. Berthe
“In Situ Control of the Dismantling Process of Laminated Composites by Laser Shock Using Ultrasonic Guided Waves”

I. Sma, T. Novellino Patricio, J.-P. M. Costa, E. Richaud, L. Berthe, E. Dubois, Y. Rouchausse, M. Rébillat
“Application of Laser Shock Dismantling to Thermally Aged Laminated Composite Waste”

Conférence



- **9th ICLPRP**, Oct. 2025, Prague — **First Place for the Best Poster Award**
- **ECCM21**, July 2024, Nantes — **First Place for the Best Poster Award**
- **8th ICLPRP**, Oct. 2023, Corée du Sud — **Gold Award – Best Poster**

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