



POLYMERS 2025, COMPOSITES 2025 AND 3BS MATERIALS TECH 2025 INTERNATIONAL JOINT CONFERENCE

16 - 18 APRIL 2025 | ALBUFEIRA, PORTUGAL

Book of Abstracts

Organizer



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Conference Room Santa Eulália

**Composites Session I. C:
Synthesis, Processing and Characterization****Session's Chairs:**

Dr. Monica Sandri, CNR-ISSMC-Faenza, Italy
Prof Gintaras Denafas, Kaunas University of Technology, Lithuania
Dr. Olga Sacco, University of Salerno, Italy

14:00 - 14:30	Hybrid toughening techniques for enhancing interlaminar fracture toughness and mechanical performance of thermoplastic composites A. Ivankovic , Y. Chen, V. Prasad, M. Yasar and N. Murphy	Prof. Alojz Ivankovic , University College Dublin, Ireland
14:30 - 15:00	Experiments and analysis of fatigue delamination in UD Layered composites J. Botsis	Prof. John Botsis , EPFL, Switzerland
15:00 - 15:15	Preliminary Design of COPV: Material Enhancement, Structural Design, and Manufacturing Process L. Bouhala, A. Laachachi and S. Klein. L. Bouhala , A.i Laachachi and S. Klein	Dr. Lyazid Bouhala , Luxembourg Institute of Science and Technology, Luxembourg
15:15 - 15:30	Folding of flax/polypropylene composites based on comingled fabric: Feasibility study S. Provost-Mattmann, V. Dos-Santos-Martins , V. Person and F. Hennebelle	Dr. Valérie Dos Santos Martins , Bourgogne Europe University, France
15:30 - 15:45	Human Robot Collaborative Draping of Carbon Fibre Composite Parts: Results of Three Case Studies C. Eitzinger , D. Zielinski and C. Frommel	Dr. Christian Eitzinger , Profactor GmbH, Austria
15:45 - 16:00	Segmentation Aware Attention Mechanism for Defect Classification of both Virgin and Recycled Carbon Fiber Fabric A. Kolli, M. Carpentieri, D. Krajnc and C. Eitzinger	Mr. Denis Krajnc , Profactor GmbH, Austria
16:00 - 16:30	Afternoon Coffee Break / Posters Session	
Session's Chairs: Prof. John Botsis, EPFL, Switzerland Prof. Alojz Ivankovic, University College Dublin, Ireland		
16:30 - 17:00	Challenges on Multilayer Composites Disintegration and Materials Recovering for Waste Printed Circuit Boards G. Denafas , G. Miliauskas , E. Andriukonis, E. Griškonis, I. Pitak, V. Makarevičius, A. Baltušnikas, R. Kriukienė, A. Šleiniūtė, R.Ivanauskas, D. Goljandin and E. Blumbergs	Prof Gintaras Denafas , Kaunas University of Technology, Lithuania
17:00 - 17:15	Defects analysis and microstructural characterization of 3D-printed sintered parts of ceramic matrix composites (cordierite-graphene) Á. García Juárez, I. Esguerra Arce , J. García-Martínez, J. Hidalgo García, L. Illán Andrés, R. Giménez Pérez, A. Pastor Muro, C. Berges Serrano, G.H. Sánchez-Cosgalla and M. García-Martínez	Mrs. Ingrid Esguerra Arce , National Institute of Aerospace Technology, Spain
17:15 - 17:30	Predictive Modeling of Porosity Characteristics in High-Pressure Hydrogen Tanks using Augmented Fuzzy Cognitive AI L. Achour , Z. Zalila, Z. Aboura, B. Lorentz, D. Ruggi and K. Khellil	Mrs. Lina Achour , Univ. of Tech. Compiègne, France
17:30 - 17:45	Material characteristics of reused carbon fibre-reinforced polymers from wind turbine blades S. Gerdes , I. Möllmann and C. Lauter	Mr. Sönke Gerdes , PHWT Private University of Applied Sciences, Germany
17:45 - 18:00	Determinaton of the Aging State of Resin Systems in Wind Turbine Blades at the End of Lifetime with IR-Spectroscopy I. Möllmann , S. Gerdes, A. Brunner and, C. Lauter	Ms. Imke Rita Moellmann , PHWT Private University of Applied Sciences, Germany
18:00 - 18:15	Optimizing Recycling: Fragmentation and Sorting of GFRP Components in Battery Housings - Impact on Recyclate Properties J. E. Grimmerstein , T. Krampitz and H. Lieberwirth	Mr. Julius Grimmerstein , TU Bergakademie Freiberg, Germany

Challenges on Multilyer Composites Desintegration and Materials Recovering for Waste Printed Circuit Boards

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Abstract:

Printed circuit boards (PCBs) are one of the most common types of multilayer composites used in many electrical and electronic equipment devices. The most important layers are Conductive Layer, Dielectric Layer, Solder Mask Layer, Silkscreen Layer. In most cases, PCBs with multiple conductive and interconnected layers are formed.

The dielectric layer can be formed from such materials as FR-4 (composite material composed of woven fiberglass cloth with an epoxy resin binder that is flame resistant), CEM materials, polyimides, Teflon, etc. The choice of these materials depends on the nature of the PCB operation. Copper is usually used for the conductive layer, for specialized PCB – also aluminum, silver, gold.

Due to technological development the nature of materials used for PCB layers is constantly changing. For example flexible PCBs are increasingly being used instead of rigid PCBs. And this affects the process of recovering valuable materials at the end of their life time due to the variety and different properties of these materials.

Generally, the process of recovering materials from used PCBs consists the main stages - mechanical crushing and separation, hydrometallurgical extraction and selective concentration of different valuable metals. At the industrial level, mechanical processes are mainly used, while hydrometallurgical extraction presents many challenges, so the right answers are still being sought at the laboratory level. Attention should also be drawn to the fact that when FR-4 is used for the dielectric layer, so after mechanical crushing it is also appropriate to recover the epoxy resins by dissolution them with

solvents, which is impossible to apply to other types of dielectric layers.

This paper shares the laboratory experience of recovering valuable materials from computer PCBs and push-button cell phone PCBs. Many current challenges are started from the sorting of used PCBs and continued on further hydrometallurgical extraction of metals, when it comes to the efficiency of leaching of rare and precious metals from the dielectric layer.

Keywords: printed circuit boards, dielectric layer, conductive layer, mechanical treatment, dissolution, hydrometallurgical extraction.



Figure 1: Figures illustrating the FR-4 residues after dissolutions of resins and hydrometallurgical extraction of metals. Gold residue is visible in the grooves of the processors plastic pieces.

References:

1. Ning, Ch. et al (2017), Waste Printed Circuit Board (PCB) Recycling Techniques, *Top Curr Chem* (Z) (2017) 375:43
2. Tatariants, M. et al (2017), Characterization of waste printed circuit boards recycled using a dissolution approach and ultrasonic treatment at low temperatures, *RSC Advances.*, 2017, 7, 37729.



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