REPAIR3D PROJECT NEWSLETTER
2023
Issue 1

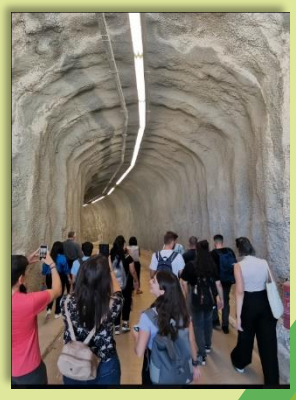
NEWSLETTER

Repair3D Project. Summer School

13 – 14 September 2022 - Greece

The Repair3D project organised a **Summer School & Training Session (SS/T)** in the framework of "*Recycling and Repurposing of Plastic Waste for Advanced 3D Printing Applications*". The SS/T took in the premises of **Lavrion Technological and Cultural Park (LTCP)** at the city of Lavrion, on the **13th and 14th of September 2022**.

The SS/T included several lectures related to plastic circularity and recycling, manufacturing of plastics composites, consumers best practices and relevant societal impacts and a visit to the Lavrion Museum



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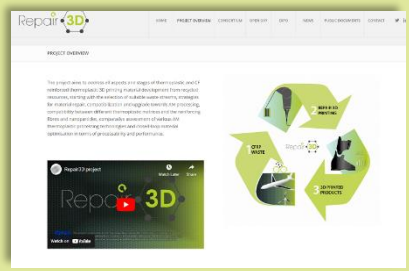
Repair3D Project- Second Open Day

The Repair3D project is organizing the 2nd Exploitation and Dissemination Workshop This will be taking place on the **30 May 2023** in **Brussels** at the at the DoubleTree by Hilton Brussels City. Participation is **FREE**!
For more information and registration to the event, please visit the Repair3D website

New design of the Repair3D website

The Repair3D Project website has received a makeover, to better illustrate the project.



Repair3D project animation video

CNT has produced an animation video, with the collaboration from Repair3D partners, who provided with videos and photos. This video has been uploaded on the project website. To watch it, **follow this link.**

www.repair3d.eu

Warrant Hub TINEXTA GROUP	R-NANO	GHENT UNIVERSITY	ADAMANT COMPOSITES	RESEARCH CENTER ITENE
LEITAT Technological Center	IRT JULES VERNE	sigmatex material innovation	eurecat Centre Tecnològic de Catalunya	BIOG3D
techedge Inspiring Trust. Globally.	DALBELLO	CENTEXBEL	MAIER	CAMBRIDGE NANOMATERIALS TECHNOLOGY LTD
	IRES	JOTIS	LAVRION TECHNOLOGICAL CULTURAL PARK	

Activities from the Repair3D Partners

Functionality testing and performance assessment of the final industrial demonstrators. (BioG3D, DALBELLO S.r.l. and Eurecat,)

ID-1 demonstrator (ski-boot) has been successfully manufactured with Fused Filament Fabrication technology, utilising recyclable materials developed within Repair3D project, reinforced with carbon fibers, magnetic nanoparticles and Ag nanoparticles, for advanced mechanical, recyclability and antibacterial properties. The developed ski-boot and insoles materials were implemented to mechanical testing and toxicological studies, to evaluate their mechanical properties and estimate their compatibility with skin contact, respectively.

ID-1 functionality testing

Visive inspection pre-testing (Major defects)

Delamination – PA12 +CF

Sole surface irregularity – resin leaks during **CFIP***

***CFIP** is a new post-process technology developed and patented by Eurecat, which enables to reinforce additive manufactured parts with continuous fibres such as carbon fibres. It is based on the simultaneous injection of continuous fibres and thermoset resin inside channels integrated into the part. Eurecat design the locations of channels, based it on topology optimization process results for the maximum allowable product space.

Visive inspection pre-testing (Minor defects)

Binding release test: The ID-1 ski-boots have been tested with a Wintersteiger Safetronic machine. The scope of the test is to verify if the release values of the skiboot-binding combination are in compliance with the ISO 11088.
The test simulates the detachment of the skiboot from the binding in 3 directions: clockwise, counterclockwise and vertical.

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Clockwise/counterclockwise release

Vertical release

Average values:

Release direction	ID-1 release values [Nm]	Expected values [Nm]*	Safe release
↻	89	78	✓
↺	92	78	✗
↑	287	320	✓

* Values based on advanced adult skier

Result: the counterclowise values is too high, probably due to the sole surface irregularity.

Lateral impact test:

The scope of this test it to asses if the ID-1 can withstand the impacts that a skiboot faces during use.

Ski-boots must withstand an impact of 40J without major breakages, the impacts on ID-1 caused delamination of the 3D printed material and therefore the non- compliance with the test.

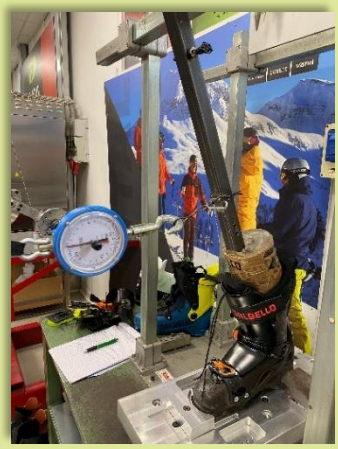
Pendulum energy [J]:	ID-1 result:	Comment
20	Slightly damaged (channels not damaged)	Delamination of 3D printed material
30	Heavy damaged (channels not damaged)	Delamination of 3D printed material
40	Heavy damaged extended also to channels	Complete breakage of shell

Stiffness test (stiffness values VS reference):

The scope of the test is to evaluate the ski-boot stiffness. To do so an automatic cyclic system had been used: a walkmeter machine. The machine simulates the in use forward and rearward motion of a ski boots and is able to collect data such as forces applied and therefore the boot stiffness
Given the fragility of the ID-1 the system to evaluate the stiffness had to be changed, infact a crack appeared within the first cycles of machine functioning.

Stiffness test (stiffness values VS reference):

An analog dynamometer had been used to evaluate frontal stiffness



ID-1 stiffness [Nm]*	Reference stiffness [Nm]*
≈ 244	≈ 248

The ID-1 shows a frontal stiffness very close to the one of the reference sample.

** Stiffnes evaluated at ≈ 45° from vertical line*

ID-4 demonstrator

The orthopaedic device (splint) realised as ID-4 demonstrator was also manufactured with Fused Filament Fabrication, exploiting dual material extrusion with recyclable thermoplastic composites reinforced with carbon-fibers, for mechanical properties enhancement, and Ag nanoparticles with antibacterial properties. The design of the splint was based on a custom parametric methodology that incorporates control of Voronoi patterns to achieve performance-driven efficiency, following design for additive manufacturing and design for recycling principles, and considering at the same time users' comfort and rehabilitation requirements based on product personalisation approaches. Finite Element Analysis (FEA), Physical Mechanical testing, Adhesion Testing and 3D Scanning procedures were implemented to ensure and evaluate the functionality and dimensional accuracy of the designed model. Toxicological and antimicrobial assessment was implemented in terms of skin sensitization.

Adhesion Testing

Custom toolpath software tools development for printability evaluation and manufacturing optimization

In order to determine the optimal printing parameters combination for the manufacturing of the demonstrators, custom-toolpath printability tests were implemented. The generated G-Code samples facilitate the performance comparison of different primary manufacturing parameters combinations, such as printing temperature and printing speed, to produce the same printing pattern. Moreover, as the demonstrators' materials were subjected to multiple recycling processes, and in order to evaluate their recyclability in relation to their printability, distinct cycles were also inspected with the developed printability assessment protocol. Through the application of the customised interdependent parametrisation tests, the fluctuations in the optimal printing parameters can be observed and inferences on the material capability in recycling and reprocessing can be drawn.

Toxicological testing for the manufactured demonstrators

Toxicological assessment of the developed 3D printed materials used in the demos was performed in vitro based on the ISO 10993-11:2017. The produced datasets are invaluable in identifying realistic exposure to dermal contact materials, since the dermal adsorption (skin sensitization) of toxic residues is one of the primary health concerns. In this context, 3D printed specimens were tested in vitro by coming in direct contact with human skin cells. The release of proinflammatory cytokines involved in immune responses was measured in the cell culture medium via Enzyme-linked immunosorbent assay (ELISA). The average of each sample was calibrated and compared with its respective control independently according to their infection times. None of the developed 3D printed materials induced a significant inflammation, as an indicator of skin sensitization.
Additionally, the 3D printed specimens were evaluated for their potential antimicrobial activity based on Ag nanoparticles additives, against Escherichia coli and Staphylococcus aureus. Although no inhibition zone was observed, the Ag-coated specimens revealed a potential antimicrobial action based on the ISO 22196:2011.

News

Participation at the World PM2022 Congress & Exhibition – October 2022

IRES represented the Repair3D project at the World PM2022 Congress & Exhibition, which took place from 9-13 October 2022 at the Lyon Congress Centre (LCC) in Lyon, France. IRES was invited to give a talk on “Sustainability in & for AM", where they also presented the Repai3D and nanoMECommons project’s relative results.

Video shooting for the “EDUCATION” News Program, GREECE

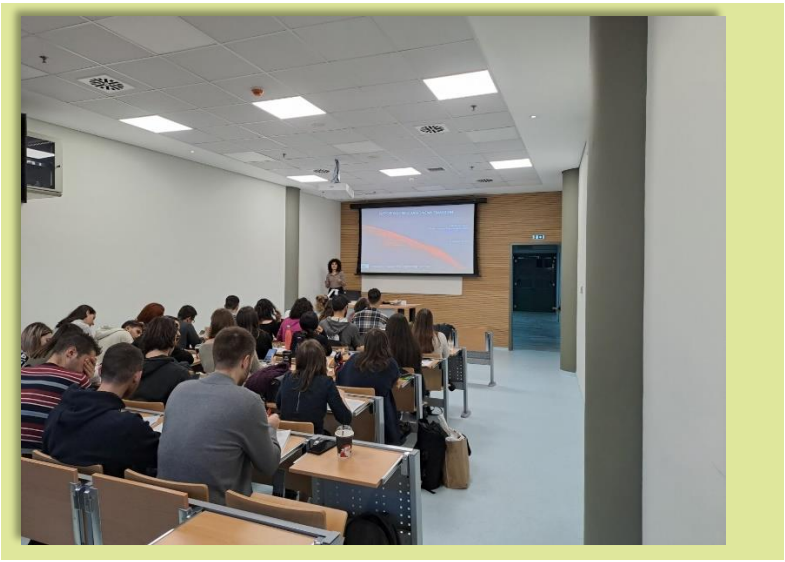
A video shooting took place on the 29 September 2022 from the Hellenic Broadcasting Corporation, related to experimental activities of RNano – NTUA (Repair3D Project Coordinator)

The activities related to the Repair3D project, demonstrated for the “Education” News Program, were specifically the electrochemical synthesis of graphene oxide, this was presented by George Konstantopoulos, PhD Candidate of NTUA.

Participation in the Researcher’s Night, September 2022- Greece

The recycling concept of Repair3D was presented to the general public, at the European Researcher’s Night. Where 100 flyers and promotional bookmarks were distributed, 3D printed samples were displayed and shared, 3D printing activities were demonstrated, project’s relevant posters were presented. The Hellenic Broadcasting Corporation took an interview from Konstantinos Zafeiris, PhD Candidate of NTUA.

Lecture on Circular Economy & Sustainable Development course at the University of Piraeus – Dec 2022



Repair3D partner **IRES,** was invited to give a lecture on how SMEs can support the transition towards Circular Economy in the frame of the MSc on Bioeconomy, Circular Economy & Sustainable Development course at the University of Piraeus (Greece).
The presentation slides provided by partner Coordinator NTUA, included general information about the Repair3D project. The lecture had the aim to motivate participants to learn more about the circular approach on composites. Around 20-25 persons (academic students and professionals) attended the event that was organized on 17 December 2022. Facts and figures about the current problem with scrap and composite EOL parts motivated them and a very interesting discussion was held after the end of the lecture including:

- If manufacturers will become also recyclers of their scrap waste, so production and recycling would take place at one site
- How H2020 projects are implemented (many had no previous experience)
- How partners are exploiting the project outcomes after the end of the project
- The reduction in carbon footprint and the cost viability of the processes (comparative values on virgin and recycled CF carbon footprint was provided just to have an idea).

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