

 : Romania

 : Serbia

 : Czech Rep.

 : Italy

 : Norway

Eastern European twinning on **S**tructural **I**ntegrity and **R**eliability of **A**dvanced **M**aterials obtained through additive **M**anufacturing - **SIRAMM**

Prof. Liviu MARSAVINA – University Politehnica Timisoara, Romania

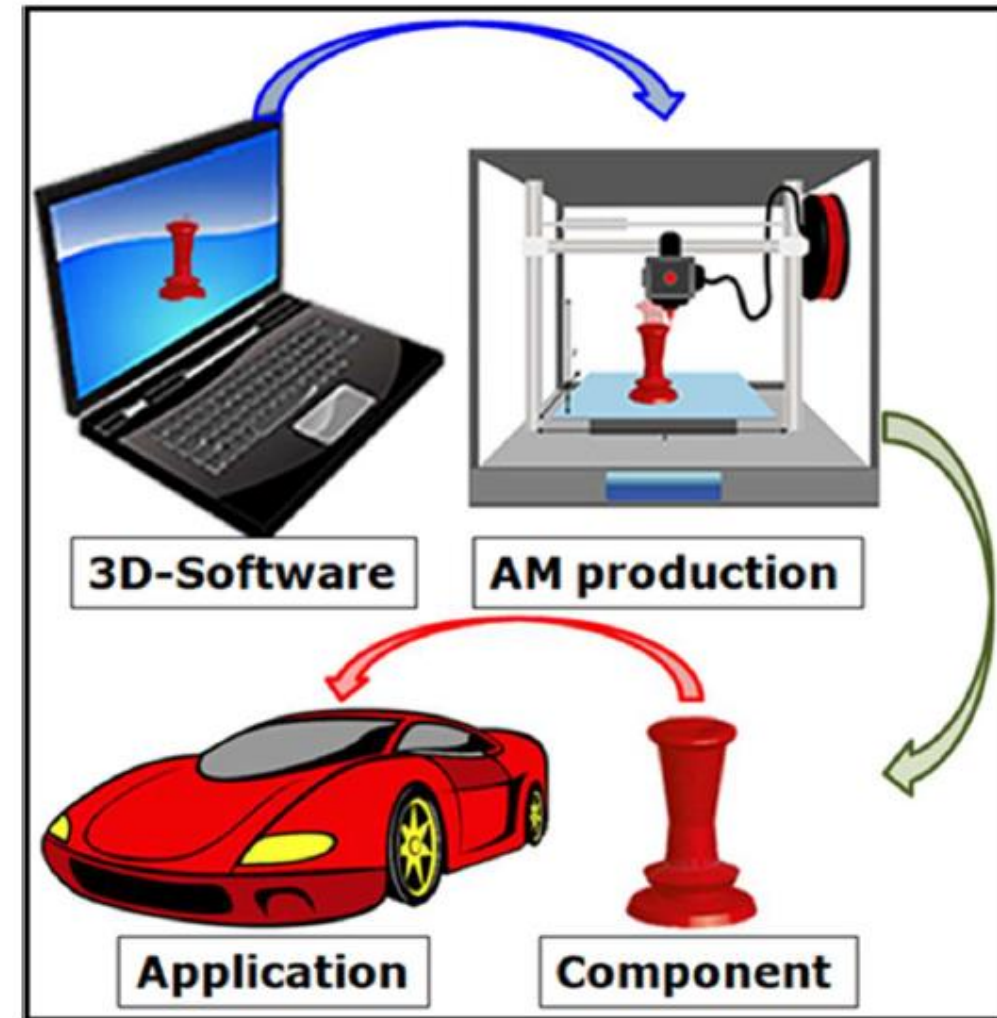
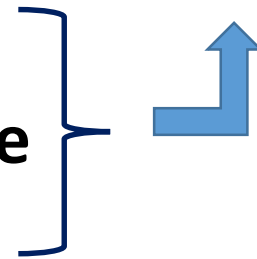


H2020-WIDESPREAD-2018
Project No. 857124

SIRAMM - Project

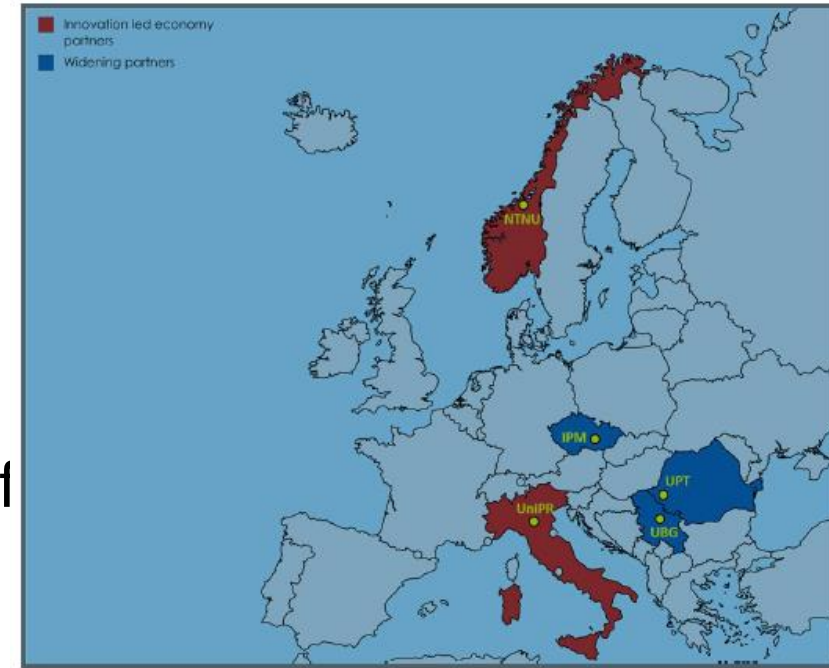
<http://www.siramm.unipr.it/>

- H2020 – CSA – Widespread – Twinning
Project No. 857124
- Duration: 36 months + 6 months
- Starting date 01.10.2019
- Budget: \approx 800.000 Euro
- Cooperation between ESIS:
TC13: Education and Training
TC15: Structural Integrity of Additive
Manufactured Components



SIRAMM - List of participants

1. Coordinator: Politehnica University of Timisoara (UPT), Romania
2. Faculty of Mechanical Engineering, University of Belgrade (UBG), Serbia
3. Institute of Physics of Materials, Academy of Sciences of the Czech Republic (IPM), Czech Republic
4. University of Parma (UniPR), Italy
5. Norwegian Univ. of Science and Technology (NTNU), Norway



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SIRAMM - Objectives

- The **overall objective** of the SIRAMM project is to significantly strengthen research in the AM field at the **Politehnica University of Timisoara** (UPT, Romania). To achieve this aim, SIRAMM will build upon the existing science and innovation base of UPT, creating a network with two internationally-leading counterparts at EU level: **Norwegian University of Science and Technology** (Norway) and the **University of Parma** (Italy).
- In the long term, the project aims at laying the foundations for creating a pole of excellence on AM in Eastern Europe. For this reason, other two partners from low R&I performing countries, the **University of Belgrade** (Serbia) and the **Institute of Physics of Materials**, Academy of Sciences (Czech Republic) will also take part in this Twinning project.
- To reach its goals, this 3-year project will be focused on the implementation of knowledge transfer activities such as workshops and staff exchange, training events (i.e. summer schools, seminars) for early stage researchers, and dissemination and communication actions (i.e. web site, videos, open access publications, public engagement activities) for different audiences. To keep maintaining the knowledge transfer well beyond the duration



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SIRAMM – Specific Objective

SO1: To enhance the scientific and technological capacity of UPT and contribute to increase its fundamental knowledge in the field of AM.

SO2: To help raise the research profile of the leading institution as well as the research profile of staff and young scholar from all the 3 widening countries participating in the project: Romania, Serbia and Czech Republic.

SO3: To create a hub of excellence on AM in Eastern Europe, by engaging with the scientific community, industry and society of the three different widening countries involved in SIRAMM.



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SIRAMM - Scientific ideas and models

- Relatively short manufacturing time and possibility of remote production with a very low human contribution make AM technology very attractive for modern industry.
- AM makes it possible to obtain parts with complex shapes and high precision characteristics.
- AM permits the assembly of materials with different physical properties to create a single element having superior qualities.
- AM processes range from advanced metal alloys to produce jet engine parts to food matters to get food items. Thermoplastic polymers (such as acrylonitrile butadiene styrene (ABS), polylactic acid (PLA), polycarbonate (PC), water-soluble polyvinyl alcohol (PVA), etc.), metals, ceramics (such as alumina and tricalcium phosphate, zirconia, etc.), biochemicals (biological inks, soft elastomers, etc.) are among the different type of materials that can be used in AM production.



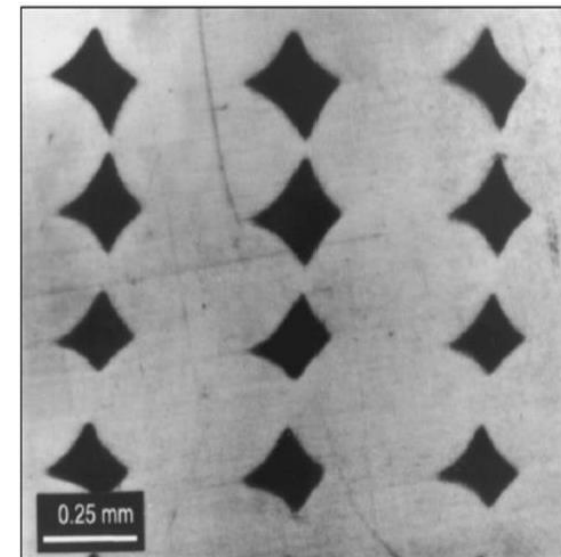
- **up to 90% saving in material !**
- **up to 85% reduction in lead time from design to approval !**

SIRAMM - Scientific ideas and models

...challenges for mechanical property characterization

- AM processes differ from traditional processing in that not all of the material is melted and homogenized.
- the AM process of depositing layers of polymeric material results in parts with anisotropic properties, residual stress and structural and fatigue problems.
- complexity in relating material properties, AM mesostructure, and part design for standardized testing.

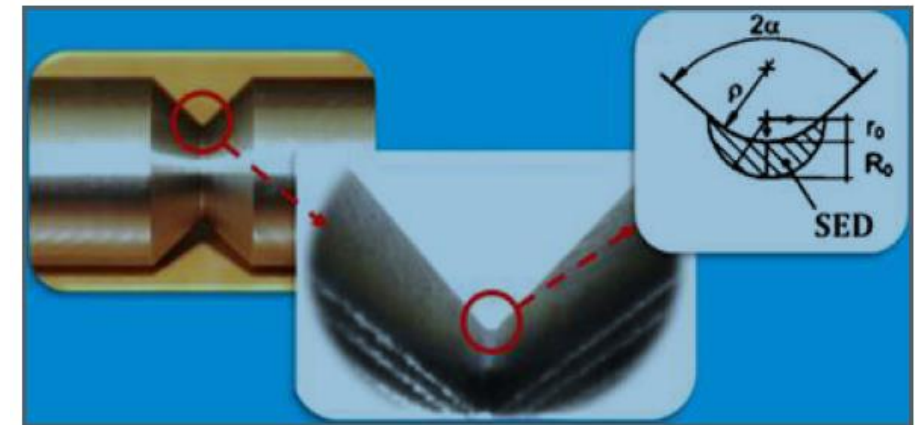
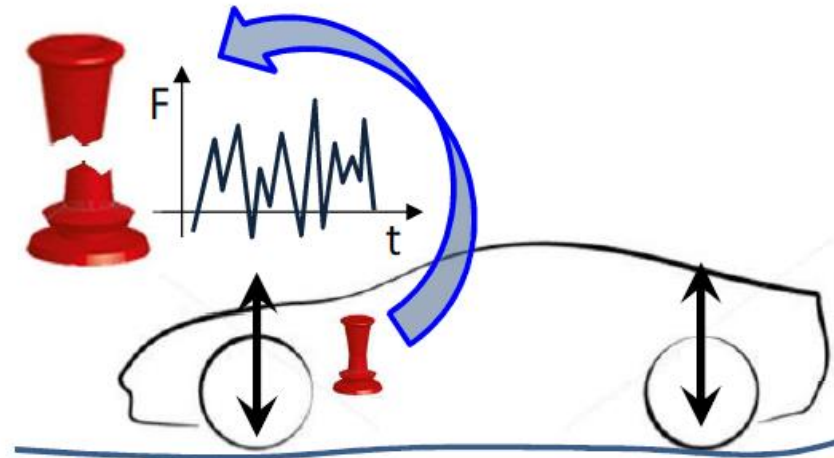
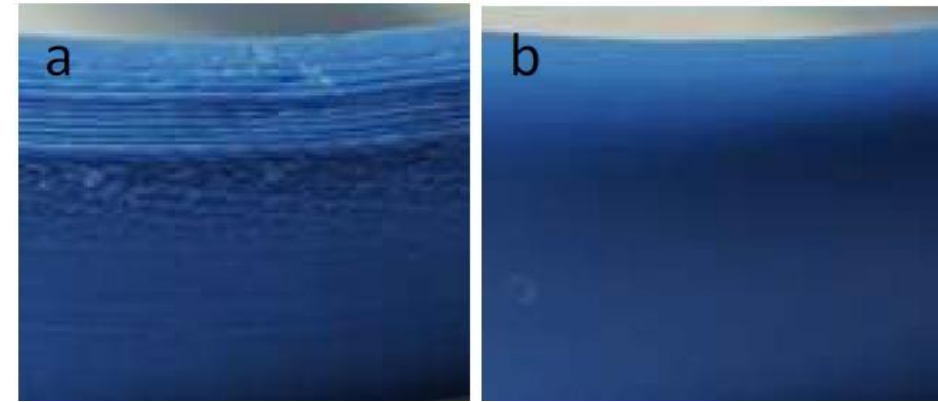
Rodriguez et al., "Characterization of the mesostructure of styrene materials, *Rapid Prototyping Journal*, 6 (3) 175–185, 2000.



SIRAMM - Scientific ideas and models

...questions about structural integrity of AM

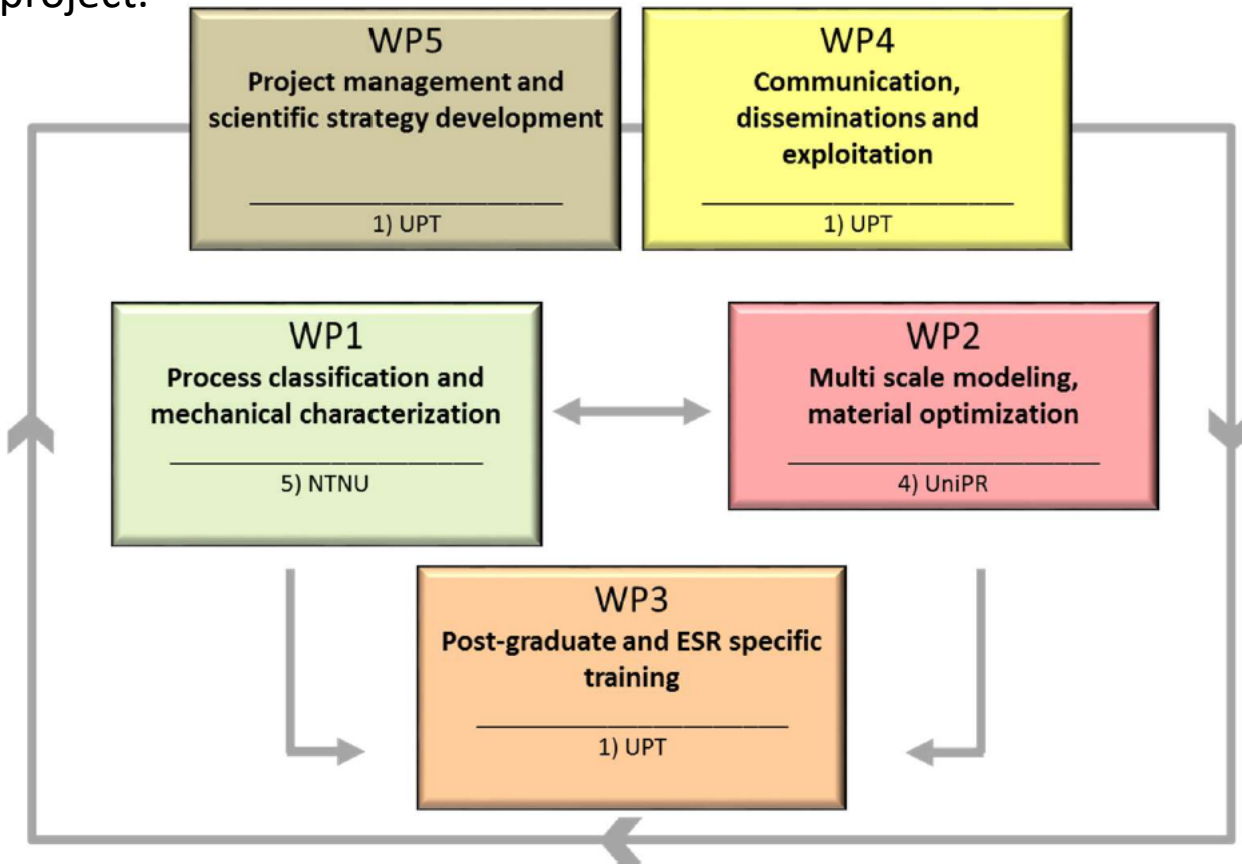
- low quality surface of an AM polymeric material
- scatter in results
- dispersion in data
- variability of lifetimes
- notch and size effect
- ...



Work plan – Work packages and deliverables

WP5 will deal with the coordination and management of all scientific, contractual, financial, and legal aspects of the project.

WP4 will be dedicated to the communication, dissemination and exploitation of the project results. ESRs will have a specific role in this WP, being involved in the development of short YouTube videos and public engagement activities within the European Researcher Night.

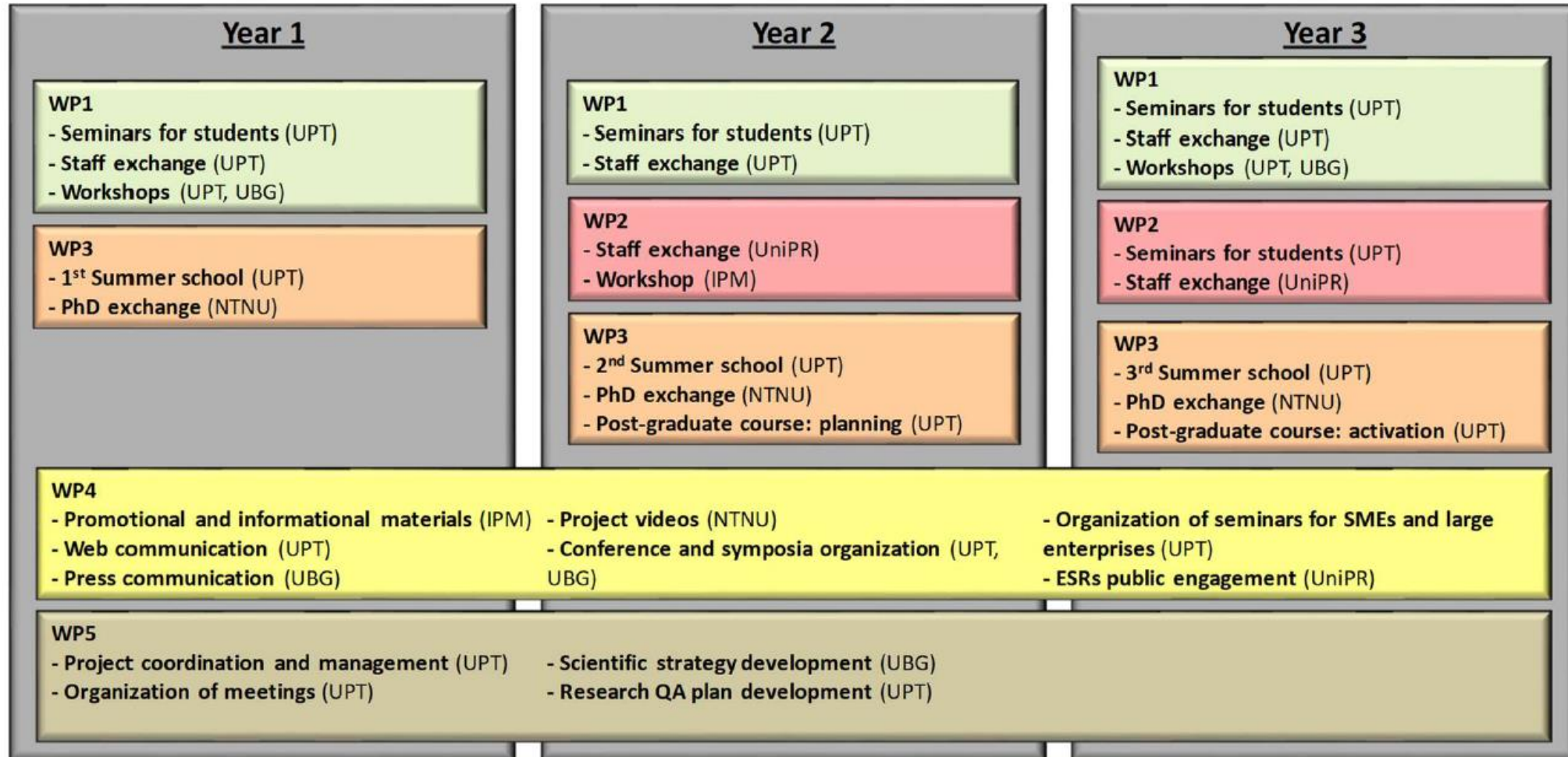


WP1 will be devoted to the transfer of knowledge and acquisition of competences on the application of different AM technologies for the production of AM specimens, their analysis and interpretation.

WP2 will be focused on the transfer of knowledge and acquisition of competences on multi scale modelling and material optimization. WP2 will take care of formulating suitable physics-based theoretical models to describe the static and fatigue behaviour of AM materials.

WP3 Training of young scholar and ESRs, implementing 3 summer schools, a regular course on AM technologies and PhD exchanges among the partner organizations.

Work plan – Work packages and deliverables



SIRAMM

Staff and PhD exchange during the project implementation

Staff Exchange (Faculty)	1 st year	2 nd year	3 rd year
From to →	    	    	    
Romania			 
Serbia			
Czech Republic			
Italy			
Norway			

PhD Exchange					
From to →	    	    	    		
Romania			 	 	 
Serbia					
Czech Republic					
Italy					
Norway					
 : Romania  : Serbia  : Czech Rep.  : Italy  : Norway					

SIRAMM

Events organized during the project implementation

	1 st year					2 nd year					3 rd year				
Event															
Seminar for students	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓	✓
Seminar for companies	✓					✓					✓	✓	✓		
Summer school (5 days)	✓							✓			✓				
Workshop (2 days)	✓							✓			✓				
East Europe conference							✓								
International Conference										✓					
 : Romania  : Serbia  : Czech Rep.  : Italy  : Norway															

Published papers – Journal papers

All open access available at
<http://www.siramm.unipr.it/Publications.htm>

- **Brighenti R., Li Y., & Vernerey F.J.** (2020). Smart polymers for advanced applications: a mechanical perspective review. *Frontiers in Materials*, 7: 196, 1-18, doi: 10.3389/fmats.2020.00196
- **Brighenti R., Cosma M.P., Marsavina L., Spagnoli A., Terzano M.** (2020). Laser-based additively manufactured polymers: a review on processes and mechanical models. *Journal of Materials Science*, 1-38, doi: 10.1007/s10853-020-05254-6.
- **Marsavina L., Linul E.** (2020). Fracture toughness of rigid polymeric foams: A review. *Fat. & Fract. of Eng. Mat. & Struct.*, (in press): 1-32, doi: 10.1111/ffe.13327
- **Linul E., Marsavina L., Stoia D. I.** (2020). Mode I and II fracture toughness investigation of Laser-Sintered Polyamide. *Theoretical and Applied Fracture Mechanics*, 106: 102497, doi: 10.1016/j.tafmec.2020.102497
- **Stoia D. I., Marsavina L., Linul E.** (2020). Mode I Fracture Toughness of Polyamide and Alumide Samples obtained by Selective Laser Sintering Additive Process. *Polymers*: 12(3), 640, doi: 10.3390/polym12030640



Published papers – Conference papers

All open access available at
<http://www.siramm.unipr.it/Publications.htm>

- **Valean C., Marsavina L., Marghitas M., Linul E., Razavi J., Berto F.**, Effect of manufacturing parameters on tensile properties of FDM printed specimens, *Procedia Structural Integrity*, 26, 2020, p.313-320 - presented at *1st Mediterranean Conference on Fracture and Structural Integrity, Athens, February 2020*.
- **Valean C., Marsavina L., Marghitas M., Linul E., Razavi J., Berto. F., Brighenti R.**, The effect of crack insertion for FDM printed PLA materials on Mode I and Mode II fracture toughness, *Procedia Structural Integrity*, 28, 2020, p.1134-1139 - presented at *1st Virtual European Conference on Fracture, June 2020*.
- **Galatanu S.-V., Scano M., Pietras D., Pirvulescu L.-D., Porcu M.C., Marsavina L., Sadowski T.** (2020). Bending behavior of AM50 Magnesium alloy under static and dynamic loading. *Structural Integrity Procedia*, 26, 2020, p. 269-276. - presented at *1st Mediterranean Conference on Fracture and Structural Integrity, Athens, February 2020*.

Organization of minisymposiums at conference

- **1st MEDFRAC** conference, Athens, 26 February 2020:
SESSION 2: CHAIR L. MARSAVINA & A. SEDMAK
MINISYMPOSIUM: INTEGRITY OF AM COMPONENTS



- **1st VECF**, online : **TC15 - Additive Materials**, Chair: **J. Razavi, C. Gao**
⇒ **VSI Engineering Fracture Mechanics: Fracture behavior of additively manufactured materials and structures**



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**1st Winter School: Trends on Additive Manufacturing for Engineering Applications,
UPT Library & Online, 24-28 Jan. 2021**

- L1: *Presentation of the SIRAMM project*, **Prof. Liviu Marsavina** (UPT, Timisoara, ROMANIA)
- L2: *Opening the design space by removing constraints with Additive Manufacturing and Topology Optimization*, **Prof. Jan Torgensen** (NTNU, Trondheim, NORWAY)
- L3: *Review on AM of polymeric materials*, **Prof. R. Brighenti, Prof. A. Spagnoli** (Univ. of Parma, ITALY)
- L4: *Fatigue properties of metallic materials produced by AM*, **Prof. Ludvík Kunz** (IPM Brno, CZECH REP.)
- L5: *Experimental Fracture Mechanics*, **Prof. D. Constantinescu** (UP Bucharest, ROMANIA)
- L6: *How to apply for research funding: funding opportunities for Early Stage Researchers and grant writing tips*, **Dr. S. Tavernini** (Univ. of Parma, ITALY)
- L7: *Numerical simulation of fatigue crack growth*, **Dr. A. Grbovic** (Univ. of Belgrade, SERBIA)
- L8: *Simulation for additive manufacturing: opportunities and challenges*, **Prof. F. Auricchio** (Univ. of Pavia, ITALY)
- L9: *Application of Fracture Mechanics parameters on structural integrity assessment*, **Prof. A. Sedmak** (Univ. of Belgrade, SERBIA)
- L10: *Local approaches in fatigue*, **Prof. F. Berto** (NTNU, Trondheim, NORWAY)
- L11: *Gender (im)balance in science and engineering across cultures*, **Prof. Roxana Ghita** (UPT, Timisoara, ROMANIA)



1st Winter School: Trends on Additive Manufacturing for Engineering Applications, UPT Library & Online, 24-28 Jan. 2021

+ 2 Practical sessions:

PS1: Designing and manufacturing of specimens (Univ. of Belgrade, Serbia)

PS2: Testing of Specimens (Univ. Politehnica Timisoara, Romania)

+ Discussions regarding grant applications and opportunities, **Dr. S. Tavernini** (Univ. of Parma, ITALY)

+ 1 PhD session (14 presentations)

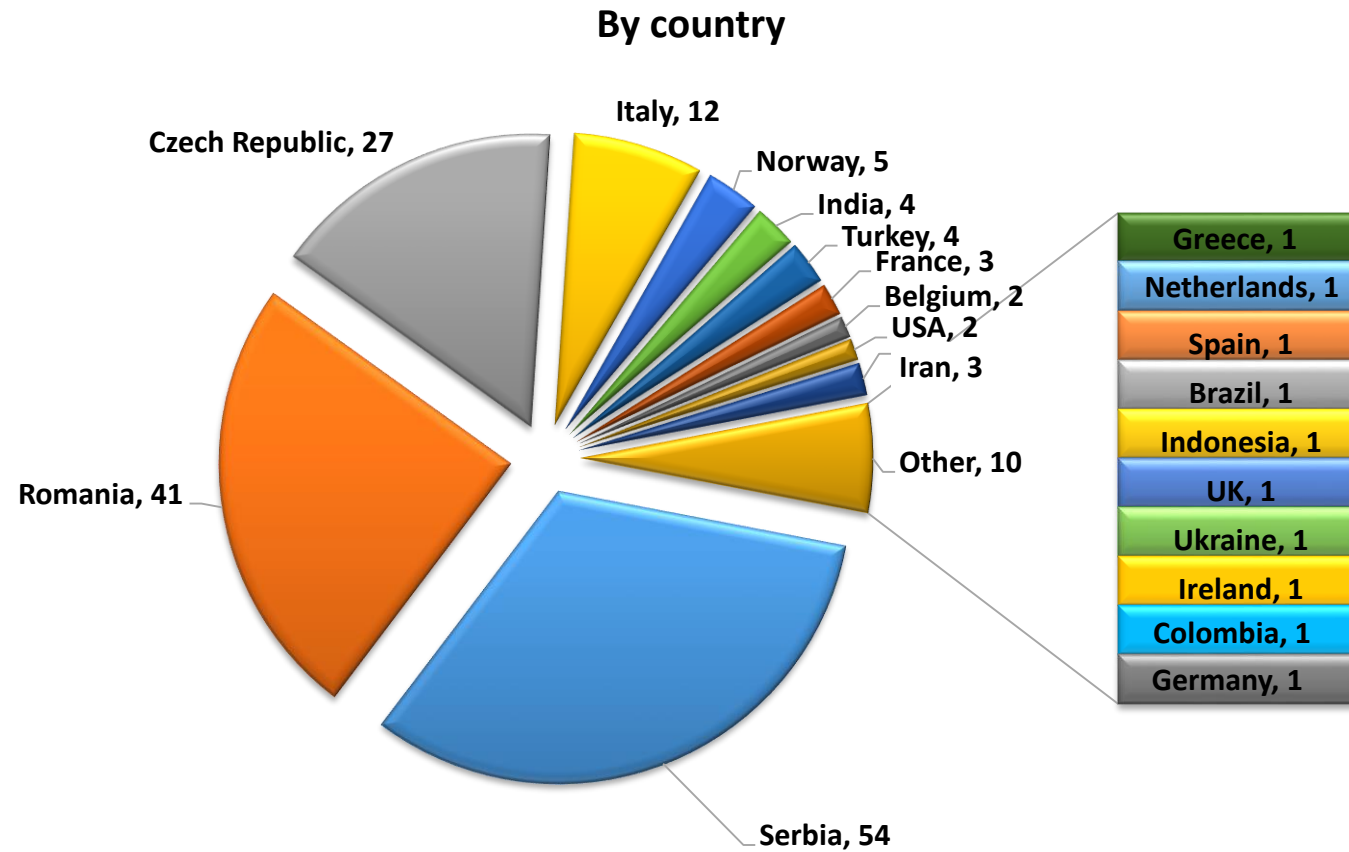
+ Other presentations (industry & universities)



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1st Winter School: Trends on Additive Manufacturing for Engineering Applications, UPT Library & Online, 24-28 Jan. 2021

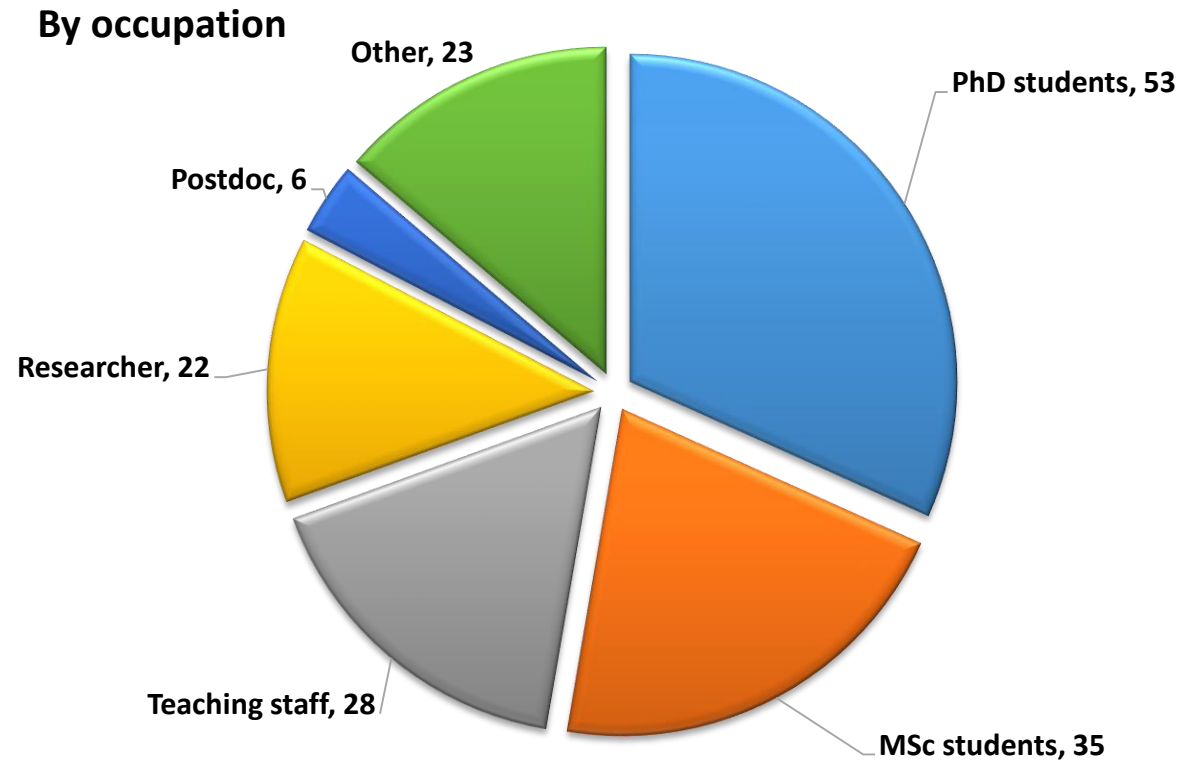
167 participants from 21 countries



H2020-WIDESPREAD-2018
Project No. 857124

1st Winter School: Trends on Additive Manufacturing for Engineering Applications, UPT Library & Online, 24-28 Jan. 2021

167 participants more than 52% students

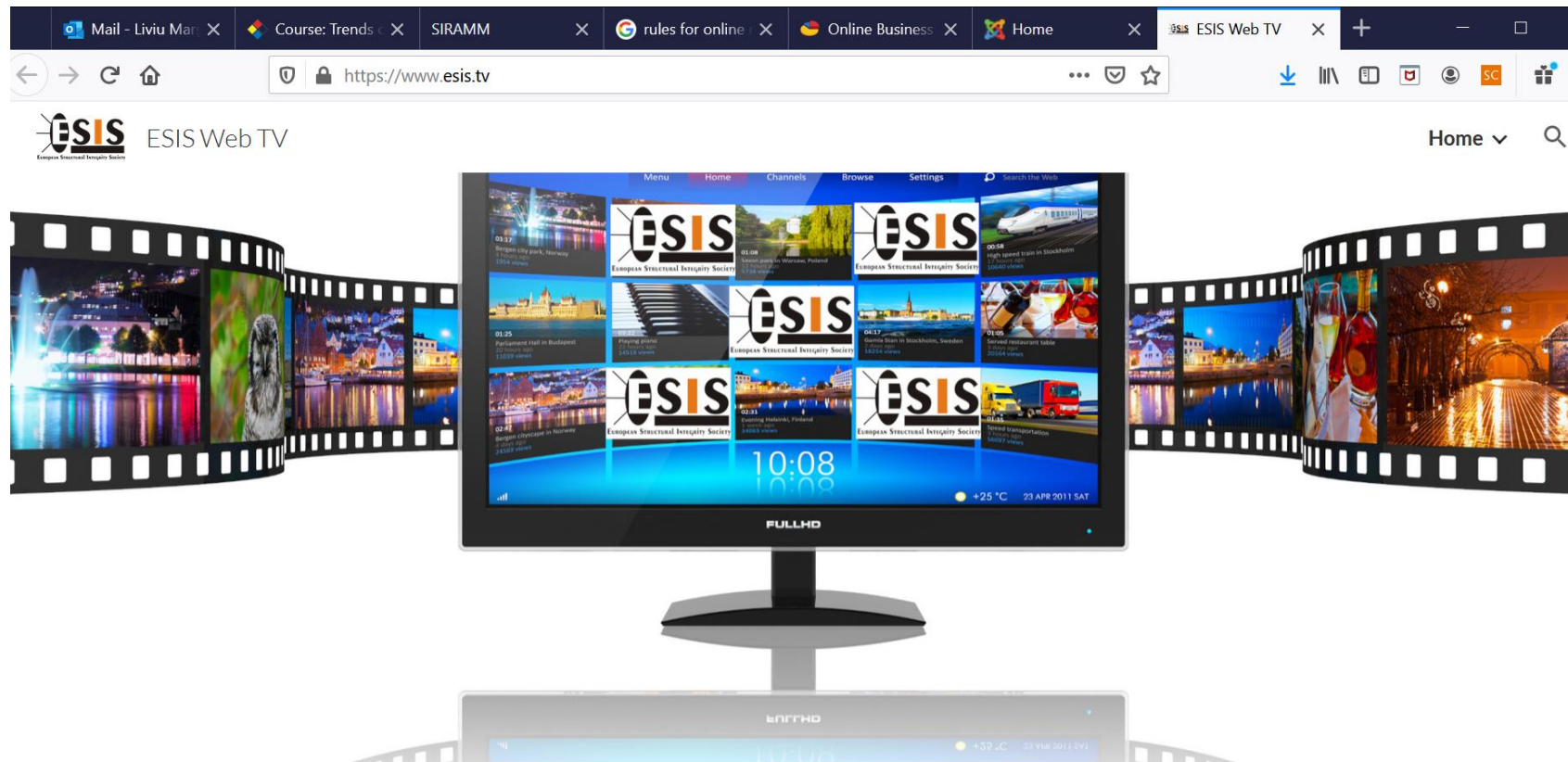


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Project No. 857124

1st Winter School: Trends on Additive Manufacturing for Engineering Applications, UPT Library & Online, 24-28 Jan. 2021

Video of lectures from 1st Winter School:

https://www.youtube.com/watch?v=jDH-Dz86_r4&list=PLqdhWx9LI8U6bBqlA4R4aU9Qzqa-XKvk5



H2020-WIDESPREAD-2018
Project No. 857124

1st Workshop on Structural Integrity of Additively Manufactured Materials, Timișoara, 25-26 February 2021

- 4 keynote lectures (Harvard University, Imperial College of London, NTNU Trondheim - 2)
- 5 sessions with 40 presentations

- *Characterization of AM materials*

- *AM technologies advancements*

- *Modeling of AM processes and materials*

- *Quality and control of AM materials*

- *Mechanics and damage of AM materials*



Proceedings:

Material Design & Processing Communications
(Wiley open access journal).



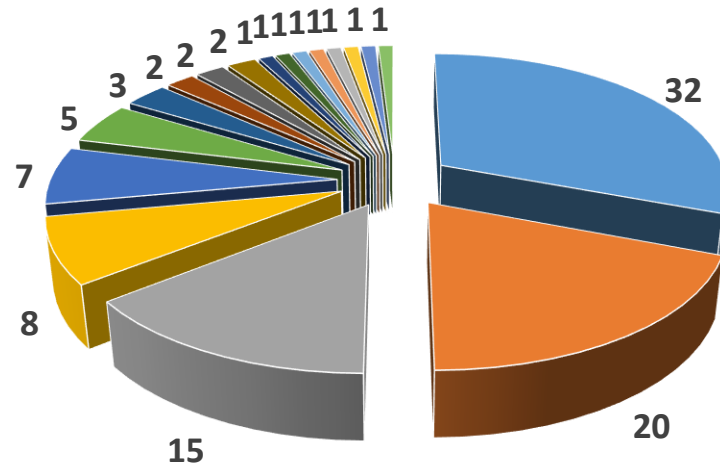
H2020-WIDESPREAD-2018
Project No. 857124

1st Workshop on Structural Integrity of Additively Manufactured Materials

Timișoara, 25-26 February 2021

104 participants from 18 countries

Participants countries



- Romania ■ Italy ■ Czech Rep ■ Serbia ■ Norway ■ Colombia
- India ■ USA ■ UK ■ Taiwan ■ Brazil ■ Spain
- Iran ■ Belgium ■ Turkey ■ Kenya ■ Morocco ■ France



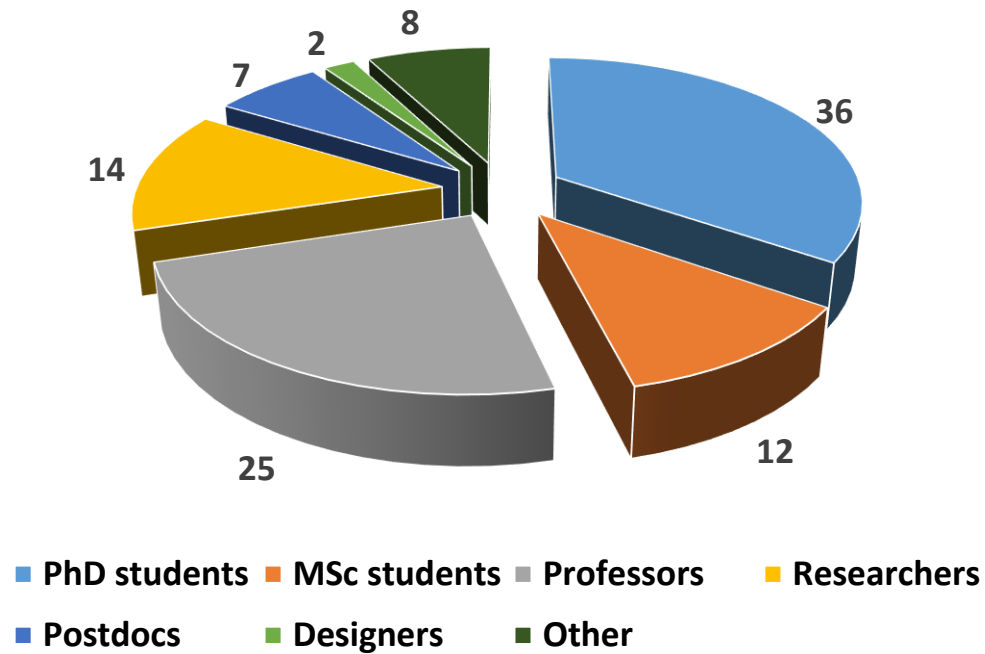
H2020-WIDESPREAD-2018
Project No. 857124

1st Workshop on Structural Integrity of Additively Manufactured Materials

Timișoara, 25-26 February 2021

104 participants from 18 countries

Participants occupation



H2020-WIDESPREAD-2018
Project No. 857124

Next events on SIRAMM

- 2nd Summer School & 2nd Workshop, IPM Brno, Czech Rep.
- East Europe Conference on AM materials – EECAM (2nd year), Belgrade, Serbia
- Final International Conference (3rd year), Timisoara, Romania
- Organization of mini-symposiums at next conferences in 2021 - 2023 (European Conference on Fracture 2022)



H2020-WIDESPREAD-2018
Project No. 857124

Experience and obstacles in project implementation

- Lack of money for research



- Changing of Project Officer



- Low support from NCP



- Support grant from Romanian ministry 10% of the budget



- Covid – 19 issues



COVID – 19 problems

- Project suspension for 6 months (April – October 2020)
- No possibility to make the staff and PhD students exchange
- Hybrid organization of Winter School, Workshop and Meetings
- Lack of instructions, recommendations from EC regarding the pandemic issues



Acknowledgments

➤ European Commission



➤ European Structural Integrity Society



THANK YOU FOR ATTENTION!



H2020-WIDESPREAD-2018
Project No. 857124