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3DH-Solutions

Restoration of exterior artworks by 3D printing and nanomaterials

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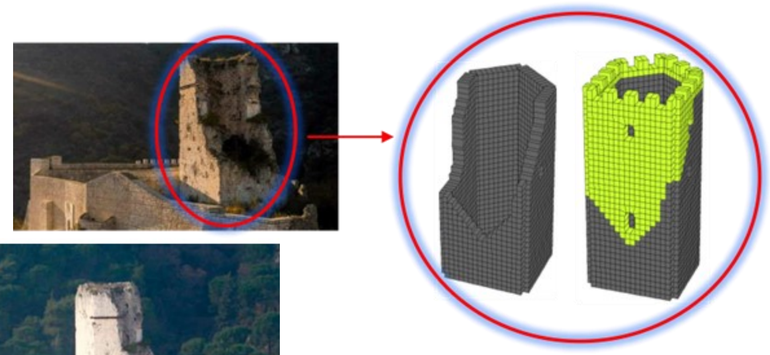
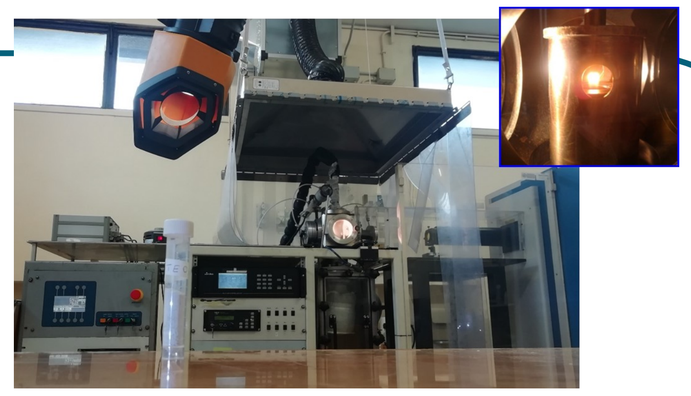
Nowadays, cultural and historical heritage undergo to a decay due to environmental pollution, natural disasters and vandal attacks, which result in damage and sometimes total loss of exterior artworks. Restoration of these artworks can be performed by reproduction of damaged or loss elements and such tasks can be resolved by means of laser additive technologies, that is employing the 3D printing coupled with 3D scanning. In the framework of **3DH-solutions** project, granted by Regione Lazio, the application and benefits of the use of 3D scanning technologies and the reproduction of scan results using 3D printers for repairing and reconstructing cultural heritage objects has investigated. Moreover, the use of nanomaterials can improve the properties of commercial printing materials. SiC, SiO_2 and TiO_2 nanopowders are synthetized by using the CO_2 laser pyrolysis technique and are tested as additive materials. Both 3D commercial printing and innovative nanocomposites materials performance is studied and their stability to environmental ageing is investigated.

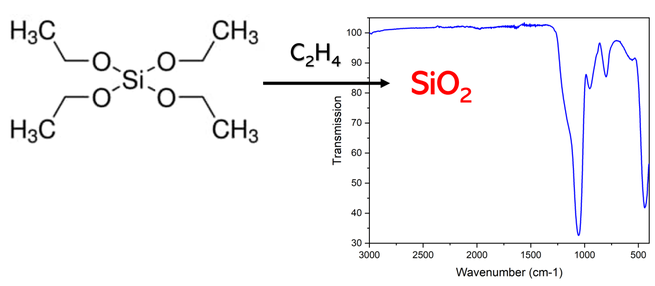


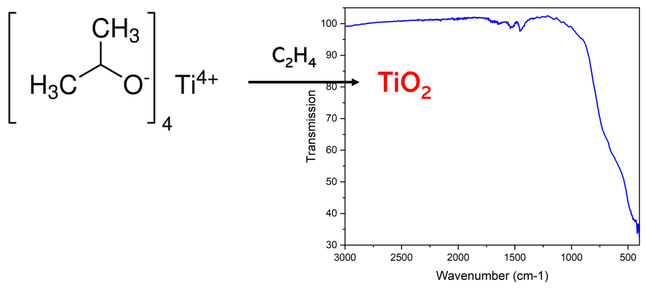
The first part of the project is concerned with the architectural surveying and graphic modeling of the two cases studies. The aims of this task of activities is to rebuilt the artworks components using both photogrammetry and laser scanner techniques. Graphic modeling is performed using the BIM (Building Information Modeling) environments. Thanks to BIM tool, damaged and loss artworks components could be modeled and rebuilt with 3D printing. Two case studies were selected: Palazzo Orsini in Amatrice and Rocca Janula in Cassino.

Nanoparticles and nanocomposites synthesis

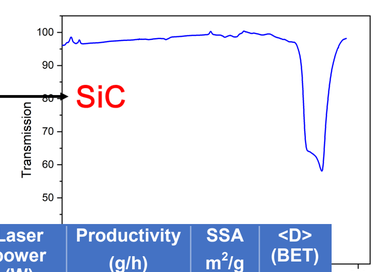
Nanopowders, to be tested with commercial printing materials, are synthetized by employing CO_2 laser pyrolysis technique starting both by gaseous and liquid precursors. The used facilities is LUCIFERO in ENEA Frascati research center. The main advantages of the laser synthesis are: high productivity, nanoparticles production with average size ranging from 5 to 60 nm and narrow size distribution and the possibility to avoid contamination due to solvent. Nanomaterials selected for the project were produced and characterized against their chemical and morphological features







$SiH_{4\ (g)} + C_2H_{2\ (g)} \rightarrow SiC$



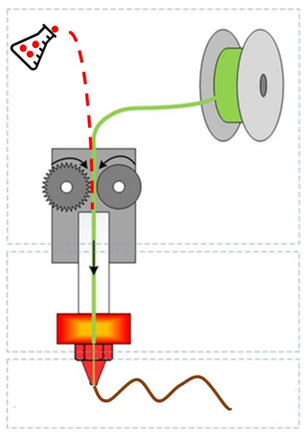
sample	TEOS (g/h)	C_2H_4 (sccm)	pression (torr)	Laser power (W)	Productivity (g/h)	SSA m^2/g	<D> (BET)
TEOS 21	60	200	400	800	14.5	199.6	12
TEOS 23	60	200	400	850	15.5	208.5	11
TEOS 25	50	100	400	900	12.0	221.7	10

sample	TTIP (g/h)	C_2H_4 (sccm)	pression (torr)	Laser power (W)	Productivity (g/h)	SSA m^2/g	<D> (BET) nm
TITA 22	45	400	350	1200	11.2	107.3	13.2

sample	SiH_4 (g/h)	C_2H_4 (sccm)	pression (torr)	Laser power (W)	Productivity (g/h)	SSA m^2/g	<D> (BET)
SiC19	500	240	600	630	58	75.7	24.8

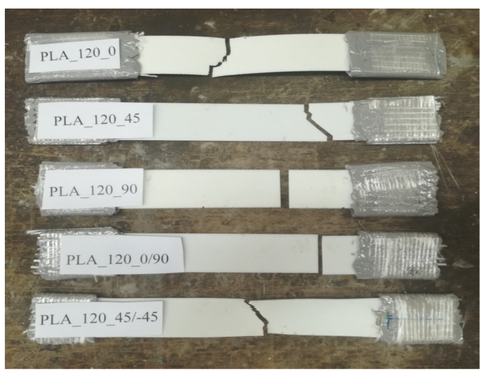
Three different nanocomposites are produced by the dispersion of nanomaterials in a polylactid acid (PLA) matrix: PLA+3% SiO_2, PLA+3% TiO_2 , PLA+3% SiC

Nanocomposites are produced by NADIR company using Melt Compounding Technology with Twin Screw Extruder. Thanks to a filament extruder, this techniques is able to provide3D printable filament with diameter from 0,5 – 3mm with constant diameter .

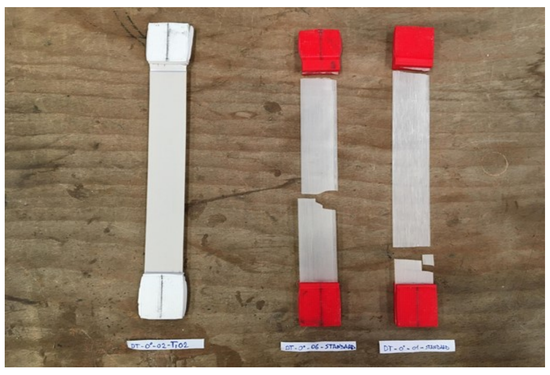


Commercial printing material (PLA) is tested, together with innovative nanocomposite. By production of a series of test samples, mechanical properties are characterized thought bend and tensile strength test. As a final step, the elements of the artifacts will be produced and the connection to the artworks is an additional key point for the success of the project.

Test specimens of commerical PLA



Test specimens of printed nanocomposites



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