

#1 Research Option Description

Doctoral Course	Sciences, Technologies and Measurements for Space
Department name	Center of Studies and Activities for Space (CISAS)
Research topic B (see Annex ,1 UNIPHD Call)	Study and development of sensors and instrumentation for measurements
Research option	Multiphysics modelling of thermal cracks in multiphase heterogenous porous materials
Supervisor	<u>Supervisor</u> : Prof. Lorenzo SANAVIA, lorenzo.sanavia@unipd.it <u>Co-supervisor</u> : Prof. Laura DE LORENZIS, ldelorenzis@ethz.ch
Webpage	https://www.researchgate.net/profile/Lorenzo_Sanavia https://www.dicea.unipd.it/en/en/en/en/en/research/research-groups/structural-mechanics-and-structural-engineering/structural-engineering-2
Context of the research activity and objectives	This research project aims to develop a numerical model able to study the nucleation and propagation of cracks induced by thermal effects in multiphase heterogenous porous materials. This model will be developed within the Thermodynamically Constrained Averaging Theory and the crack phase-field approach to brittle/ductile fracture. The starting point will be the merge of a thermodynamically consistent multiphase porous media model with the associated finite element code Comes-Geo developed at the UNIPD and a crack phase-field model with the associated fem code for brittle fracture developed at ETH Zurich. After validation with new original experiments designed from the numerical modelling and conducted at EPFL Lausanne by the doctoral student, the model will be further extended. The combination of the outcomes of the developed model and the experimental measurements will allow a step forward on the interpretation of the fracture in multiphase porous materials and its multiphysics nature. This will also allow new insights for designing innovative experiments and measurements. Applications of this project pertain to space engineering/planetary geology, environmental engineering and structural engineering for composite porous structures.
Infrastructures	UNIPD-CAPRI and ETH clusters for HPC. Soil mechanics lab. at EPFL.
Skills and competencies for the development of the activity	Competencies on continuum and computational mechanics (and possibly, in geomechanics). Skills in coding for scientific applications.
Training offer	30 ECTS credits in educational activities among the PhD courses offered at Univ. of Padua, ETH Zurich and EPFL Lausanne.
Possible Secondments	<ul style="list-style-type: none"> - ETH Zurich, Prof. Laura DE LORENZIS, Dep. of Mechanical and Process Engineering, Computational Mechanics Lab – 6-12 months. - EPFL Lausanne, Prof. Lyessse LALOUI, LMS lab - 3 months. - M3E Mathematical Methods and Models for Engineering s.r.l., Padua, CEO Dr. Nicolò SPIEZIA – 3 months.