UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR	**PhD OFFER** **ÉCOLE DOCTORALE SCIENCES EXACTES ET LEURS APPLICATIONS - ED 211 / NATURAL SCIENCES DOCTORAL SCHOOL** Avenue de l'université BP 1155 64 013 PAU Cedex – France

PhD SUBJECT

TITLE: X-ray tomography for in-situ characterization of crystallization damage in layered artworks

a PhD offer within the EU JPI-CH project CRYSTINART (Crystallization damage at the interfaces of artworks)

ABSTRACT:

One of the most common deterioration problems affecting cultural heritage worldwide is crystallization damage caused by an interplay between salts, environmental changes and material properties. Especially porous materials are susceptible to salt crystallization. It threatens artworks such as sculptures, ceramics, frescoes, paintings, archeological objects and buildings in museums as well as outdoor environments. Most of these artworks are made of an assembly of layered materials with different physicochemical properties. Additional layers of material are sometimes added as conservation measures. The properties of all materials involved and the interfaces between these materials affect the artwork's susceptibility to deterioration.

As a PhD student within the CRYSTINART consortium, you will focus on the use of high-resolution X-ray computed tomography to characterize salt damage across layered artwork systems. You will mimic salt weathering scenarios in a climatic chamber, and once realistic scenarios defined, you will translate them to the X-ray tomograph. Time-resolved high-resolution X-ray computed tomography allows to follow the changes in the internal structure of the layered porous materials in-situ, and to monitor brine and salt crystal distributions as a function of time in a non-destructive way. Subsequently, you will set up image analysis workflows to derive quantitative data from the X-ray scans that can then be employed as direct input for theoretical crystallization damage models and for numerical studies.

Keywords: artwork materials, composite, interfaces, crystallization, damage

GENERAL INFORMATION

Laboratory : Laboratoire des Fluides Complexes et leurs Réservoirs UMR 5150

Web site : https://lfc.univ-pau.fr/

PhD Director: Hannelore DERLUYN

In collaboration with: Noushine SHAHIDZADEH, Leo PEL, Stefano DE MIRANDA, Isabelle GARACHON

Place: Pau, France

Start date: October 2020	**Duration:** 3 years

Employer: Université de Pau et des Pays de l'Adour (UPPA)

Monthly salary before taxes: 1900 €

WORK CONTEXT

You will work within the CRYSTINART consortium. CRYSTINART (Crystallization damage at the interfaces of artworks) is an EU JPI-CH funded project. Four academic partners are involved: project leader N. Shahidzadeh of the University of Amsterdam (The Netherlands), L. Pel of Eindhoven University of Technology (The Netherlands), S. de Miranda of the University of Bologna (Italy), and H. Derluyn of the University of Pau and Pays de l'Adour (France); as well as one associate partner, the Rijksmuseum of Amsterdam.

As a PhD student under supervision of Dr. Derluyn (CNRS Associate Scientist), you will be hosted at the Laboratory of Complex Fluids and their Reservoirs (LFCR UMR 5150) and the Pau Centre for X-ray Imaging (DMEX UMS 3360) at the UPPA in France, on its campus in Pau. You will be registered as a PhD student at the Doctoral School of Exact and Applied Sciences ED 211 SEA, an ISO 9001 certified school. You will work closely with the other partners in the CRYSTINART consortium, and with the PRD-Trigger team that is being set up in the framework of the ERC Starting Grant of Dr. Derluyn (YouTube interview; CNRS INSIS profile).

MISSION – PRINCIPAL ACTIVITIES

One of the most common deterioration problems affecting cultural heritage worldwide is crystallization damage caused by an interplay between salts, environmental changes and material properties. Especially porous materials are susceptible to salt crystallization. It threatens artworks such as sculptures, ceramics, frescoes, paintings, archeological objects and buildings in museums as well as outdoor environments. Most of these artworks are made of an assembly of layered materials with different physicochemical properties. Additional layers of material are sometimes added as conservation measures. The properties of all materials involved and the interfaces between these materials affect the artwork's susceptibility to deterioration.

Much progress has been made in recent years to understand the impact of salt crystallization in single materials. In the more realistic scenario of multiple materials, many questions remain unanswered related to the interfaces between material layers.

Within the CRYSTINART consortium, we aim to develop an integrated approach for modelling and analysis of the decay of artworks due to salt crystallization in layered materials. We will combine experimental, theoretical and numerical studies at the micro-scale to model the interaction between salt crystallization and mechanical response at the interface regions of layered materials. We will translate this information to what happens on the macro-scale, and develop effective predictive and user-friendly tools that describe macroscopic material behaviour for a broad range of artefact types. This enables the prediction of damage scenarios for layered materials in artworks. We aim to develop new conservation strategies based on these predictions, and make them internationally available.

As a PhD student at UPPA, you will focus on the use of high-resolution X-ray computed tomography to characterize salt damage across layered artwork systems. This will complement experimental work performed by another researcher with magnetic resonance imaging (NMR) at Eindhoven University of Technology, and with confocal Raman and 3D-laser scanning microscopy at the University of Amsterdam. You will mimic salt weathering scenarios in a climatic chamber, and once realistic scenarios defined, you will translate them to the X-ray scanner. Time-resolved high-resolution X-ray computed tomography allows to follow the changes in the internal structure of the layered porous materials in-situ, and to monitor brine and salt crystal distributions as a function of time in a non-destructive way. Subsequently, you will set up image analysis workflows to derive quantitative data from the X-ray scans that can then be employed as direct input for theoretical crystallization damage models and for numerical studies performed at the University of Bologna.

The project duration is 3 years, during which a research-stay of 3 months is foreseen at Eindhoven University of Technology with Dr. Leo Pel to work on NMR measurements in order to merge X-ray micro-tomography and NMR data.

REQUIRED COMPETENCES

The candidate should hold a master degree in civil engineering, physics, physical chemistry, materials science, geosciences or conservation science. Candidates who are finalizing their master's program and will obtain their master degree this summer are also eligible and are strongly encouraged to apply.

Previous experience with the characterization of porous media and tomographic imaging is an asset, but not mandatory. The candidate should have a strong interest in performing experimental work in a multi-disciplinary team. Proficiency in English is mandatory.

CRITERIA USED TO SELECT CANDIDATE

Selection process steps:
- constitution of the selection committee
- evaluation of the submitted applications
- interview with the selected candidates and ranking

Criteria used in selection of the candidate:
- candidate's motivation, scientific maturity and curiosity
- academic results
- English proficiency

REQUIRED APPLICATION FILE

Send an e-mail to Dr. Hannelore Derluyn with your application containing:
- cover letter (including your motivation for applying)
- CV
- transcripts of diplomas and lists of courses attended (with grades obtained)
- recommendation letters
- names and contact details of (at least two) references

APPLICATION DEADLINE :

6 July 2020

CONTACTS e-mail :

Dr. Hannelore Derluyn:
hannelore.derluyn@univ-pau.fr