Project report 2020

POMADE

POlymer-Metal-fiber Adhesions DElamination control

MAIN PARTICIPANTS

Tetsuya Uchimoto[a]	Nicolas Mary[b]	Sebastien Livi[C]	Benoit Ter-ovanessian[d]
Bernard Normand[d]	Sabrina Marcelin[d]		

[a] *Tohoku Univ-IFS, Sendai, Japan*
[b] *CNRS-UdL-Tohoku Univ. - ELyTMaX, Sendai, Japan*
[c] *INSA Lyon-CNRS, IMP@INSA, Villeurbanne, France*
[d] *INSA Lyon-CNRS, MATEIS, Villeurbanne, France*

Contact: uchimoto@ifs.tohoku.ac.jp ; nicolas.mary@insa-lyon.fr

OVERVIEW *(keep within this page)*

Starting year: 2017 **Current researchers** (permanent/non-permanent): 4 / 1

Positioning *(Multiple selection allowed – total 100%)*	Transportation	Energy	Eng. for Health
Materials and structure design	25%	25%	
Surfaces and interfaces	25%	25%	
Simulation and modeling			

Other:

Include partner from ☐ Outside ELyT ☐ Industry

Main funding source(s)
☐ Public project(s) ☐ Industrial ☒ Own resources

IFS CRP/LyC project? ☒ Yes ☐ No

For main projects: Agency / year / name of project *(up to 3, past projects in gray)*

- none

Estimated annual budget: €10,000

Highlights & Outstanding achievements *(3-5 bullet points)*

- New polymer epoxy-Ionic Liquid materials showed high water uptake resistance
- Ratio between epoxy and ionic liquids tunes the physical and chemical properties of the polymer
- Water uptake change the coating permittivity which can be investigated by either capacitive of electrochemical impedance measurements

Illustration *(5x5 cm² max)*

PROJECT DESCRIPTION

Background (10 lines max; Calibri 11)

Epoxy-Amine coatings are widely used for corrosion protection of metallic surfaces in industry. However, their mechanical behaviors need to be improved in order to increase their range of applications. Thus, fibers (glass, carbon, etc.) can be injected in the polymer layer. Their presences create new heterogeneities, in volume and also at the internal interface between the coating and the substrate. All of them affect the overall corrosion behavior of the structure during static or dynamic loads. To optimize coatings and adhesion properties, additional knowledges are required in term of corrosion propagation and delamination mechanism at the material/polymer or polymer/fiber interfaces. Our aim is to combine complementary nondestructive measurements such as electrochemical impedance spectroscopy and eddy currents methods, to better understand the delamination processes that occurs at all interfaces heterogeneities in order to develop new hydride polymer/fiber coatings.

Key scientific question (2 lines max; Calibri 11)

How to tune epoxy ionic liquid materials to optimize water uptake.
Identification of the water uptake and adhesion mechanism to enhance coating performances.

Research method (8 lines max; Calibri 11)

In 2017/2018, at MATEIS & IMP, coating material were prepared during the stay of L. Ollivier-Lamarque. This time only epoxy polymer coatings were made. At IFS/ELyTMaX, water uptake during immersion tests were followed by NDE (capacitive sensor) and impedance measurements. Results comparisons with results obtained by Dr Marcelin at MATEIS with electrochemical technics are ongoing.
In 2018/2019, optimization of the capacitive measurement on polymer disc were performed. In parallel, a coplanar sensor was developed. Analyze of results are ongoing at this date. A work has been also performed on the modeling of the capacitance based on the modification of the permittivity of the coating when water penetrate. Mr L. Ollivier-Lamarque has been enrolled as DD PhD student from April 2019 in TU and December 2019 at INSA Lyon.

Research students involved *(gray color for previous years)*

Ph.D. candidates (years, institution):

- L. Ollivier-Lamarque (2019-2021, DD INSA/TU)

Master/Bachelor students (years):

- L. Ollivier-Lamarque (2017-2019, DD INSA/TU)

Visits and stays *(gray color for previous years)*

FR to JP (date, duration):

- S. Livi (Assoc. Prof) stay at ELyTMaX and IFS (TU), January 2020 (1 week).

JP to FR (date, duration):

- L. Ollivier-Lamarque (DD Master), stay at ELyTMaX@Lyon, November 2018 (1 week)
- L. Ollivier-Lamarque (DD Master), stay at IMP (INSA-Lyon), July 2018 (1 week)
- L. Ollivier-Lamarque (DD Master), stay at MATEIS (INSA-Lyon), July 2018 (1 week)
- L. Ollivier-Lamarque (DD Master), stay at MATEIS (INSA-Lyon), July 2018 (1 week)
- L. Ollivier-Lamarque (DD PhD), stay at MATEIS (INSA-Lyon), October 2018 (10 days)
- T. Uchimoto (Prof.), stay at MATEIS (INSA-Lyon) & ELyTMAX@Lyon, November 2018 (1 week)

- N. Mary (Assoc. Prof.), stay at MATEIS (INSA Lyon), November 2018 (1 week)
- T. Uchimoto (Prof.), stay at MATEIS (INSA-Lyon) & ELyTMAX@Lyon, July 2018 (1 week)
- N. Mary (Assoc. Prof.), stay at MATEIS (INSA Lyon), September 2019 (1 week)

COMMUNICATIONS AND VALORIZATION

Journal publications *(gray color for previous years)*

	Authors	Title	Journal	Vol.	pp. / ID	Year	DOI
1	L. Ollivier-Lamarque*, M. Lallart, T. Uchimoto, N. Mary, S. Livi, S. Marcelin, H. Miki	Dielectric analysis of water uptake in polymer coating using spatially defined Fick's law and mixing rule	Progress in Organic Coatings	148	105846	2020	10.1016/j.porgcoat.2020.105846
2							

Conferences *(gray color for previous years)*

	Authors	Title	Conference	Date	City	Country	DOI *(if applicable)*
1	L. Ollivier-Lamarque*, M. Lallart, T. Uchimoto, N. Mary, S. Livi, S. Marcelin, H. Miki	Water Uptake Assessment in Polymer Coating from Dielectric measurements Using Local Mixing Rule Coupled with Cole-Cole Equation	Eurocorr2020	09/2020	Brussel	Belgium	
2	l. Ollivier-Lamarque, T. Uchimoto, N. Mary, S. Livi, S. Marcelin, B. Ter-Ovanessian	Evaluation of Water Uptake in Ionic Liquid Composite Polymer Coating: Comparison between Gravimetric and Capacitance Measurements. And Polymer metal fiber adhesions delamination control.	Sixteenth International Conference on Flow Dynamics (ICFD 2019),	06/11/2019-08/11/2019	Sendai	Japan	
3	L. Ollivier-Lamarque*, T. Uchimoto, N. Mary, S. Livi, S. Marcelin, B. Normand, B. Ter-Ovanessian	Water Uptake in anti-corrosion polymer coating: development of capacitive measurement methods	Eurocorr2019.	09/09/2019 – 13/09/2019	Seville	Spain	
4	L. Ollivier-Lamarque, T. Uchimoto, N. Mary, S. Livi, S. Marcelin, B. Normand	*Evaluation of Water Uptake in Anti-Corrosion Polymer Coating by Capacitance Measurement*,	15th International Conference on Flow Dynamics	November 7-9, 2018	Sendai	Japan	

	L. Ollivier-Lamarque, T. Uchimoto, N. Mary, S. Livi,	*Development of electromagnetic non-desctructive testing on polymer-ionic liquid composite coating for corrosion protection*,	23rd International Workshop on Electromagnetic Nondestructive Evaluation (ENDE2018)	September 10-13, 2018	Detroit	USA	

Patents *(gray color for previous years)*

	Inventors	Title	PCT #	Year
1				

Others *(gray color for previous years)*

	People	Event	Description	Date