

Project Title : **Developing cooperation in corrosion science and engineering**

Abstract

The scientific area of collaboration will be focused on Corrosion Science and Engineering, disciplines devoted to prevent, slow down and manage the effects of corrosion on materials and structures. As a matter of facts, corrosion is the destructive attack of a material by reaction with its environment and the serious consequences of the corrosion process have become a problem of worldwide significance. The optimal corrosion management practices can have a positive impact on industries by maximising efficient and safe productions as well as on cultural heritage safeguard. The leitmotiv of the project is to take profit of the experience gained by research groups involved aimed to identify the degradation causes of metallic artefacts of archaeological and artistic interest, to find reliable conservation methods and to select the most safe exposure conditions able to ensure a long life and the best fruition to these precious witnesses of the human creativity and technology. The main objective is the transfer and the dissemination of know how through training activities on the use of advanced diagnostic and environmental monitoring facilities to be extended to the industrial area.

Politecnico di Torino: Applicant

Name	Emma
Surname	Angelini
Academic position	Full Professor
Department	DISAT - Department of Applied Science and Technology [8]
Publication 1	Low-Cost Impedance Spectroscopy System Based on a Logarithmic Amplifier. Sabrina Grassini; Simone Corbellini; Emma Angelini; Franco Ferraris; Marco Parvis (2015), IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, vol. 64 n. 5, pp. 1110-1117. - ISSN 0018-9456
Publication 2	EIS measurements for the assessment of the conservation state of metallic works of art. Angelini E.; Assante D.; Grassini S.; Parvis M. (2014), INTERNATIONAL JOURNAL OF CIRCUITS, SYSTEMS AND SIGNAL PROCESSING, vol. 8, pp. 240-245. - ISSN 1998-4464
Publication 3	The role of surface analysis in the strategies for conservation of metallic artefacts from the Mediterranean Basin. E. Angelini;A. Batmaz;T. De Caro;F. Faraldi;S. Grassini;G.M. Ingo;C. Riccucci (2014) , SURFACE AND INTERFACE ANALYSIS, vol. 46 n. 10-11, pp. 754-763. - ISSN 0142-2421
Publication 4	Plasma treatments for the cleaning and protection of metallic artefacts. Angelini E.; Grassini S.; Tusa S. (2013) , Corrosion and conservation of cultural heritage metallic artefacts / P.Dillmann, D. Watkinson, E. Angelini, A. Adriens (EFC-WP21 on Corrosion of Archaeological and Historical Artefacts). Woodhead Publishing Limited, Cambridge, pp. 552-569. ISBN 9781782421542
Publication 5	An in situ corrosion study of Middle Ages wrought iron bar chains in the Amiens Cathedral. Grassini S; Angelini E; Parvis M; Bouchar M; Dillmann P; Neff D (2013),APPLIED PHYSICS. A, MATERIALS SCIENCE & PROCESSING, vol. 113 n. 4, pp. 971-979. - ISSN 0947-8396

Politecnico di Torino: Second person of the research group involved in the mobility

Name	Marco
Surname	Sangermano
Academic position	Assistant Professor
Department	DISAT - Department of Applied Science and Technology [8]
Politecnico di Torino: Other Research group members	

How many other members of the research group are expected to be involved in the mobility (from Politecnico di Torino to the Partner University)? 2

Politecnico di Torino: Third member of the research group involved in the mobility

Name	Sabrina
Surname	Grassini
Academic position	Professore II fascia
Department	DISAT - Department of Applied Science and Technology [8]

Politecnico di Torino: Fourth member of the research group involved in the mobility

Name	Elisabetta
Surname	Di Francia
Academic position	Ph.D student
Department	DISAT - Department of Applied Science and Technology [8]

Partner University

Please select the country of the Partner University. Colombia

University name Antonio Nariño

Partner University: Partner coordinator

Name	Carlos
Surname	Arroyave
Academic position	Full Professor
Department	Antonio Nariño University
Email address	carlosenrique.arroyave@gmail.com

Publication	Study of the Copper Corrosion Mechanism in the Presence of Propionic Acid Vapors Echavarria, Alejandro; Echeverria, Felix; Arroyave, Carlos, et al. JOURNAL OF THE BRAZILIAN CHEMICAL SOCIETY Volume: 20 Issue: 10 Pages: 1841-1848 Published: 2009
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Publication 2	INFLUENCE OF ENVIRONMENTAL FACTORS IN THE ATMOSPHERIC CORROSION OF COPPER IN THE PRESENCE OF PROPIONIC ACID Echavarria, A ; Echeverria, Gil, H ; Arroyave, C , JOURNAL OF THE CHILEAN CHEMICAL SOCIETY Volume: 54 Issue: 3 Pages: 212-217 Published: SEP 2009
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Publication 3	Characterization of atmospheric corrosion products of zinc exposed to SO2 and NO2 using XPS and GIXD Castano, Juan G.; Arroyave, Carlos; Morcillo, Manuel JOURNAL OF
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	MATERIALS SCIENCE Volume: 42 Issue: 23 Pages: 9654-9662 Published: DEC 2007
Publication 4	Paintings pigmented with doped magnetite: preliminary evaluation of anticorrosive properties Marcela Escobar, Diana; Arroyave, Carlos; Calderon, Jorge; et al. REVISTA FACULTAD DE INGENIERIA-UNIVERSIDAD DE ANTIOQUIA Issue: 41 Pages: 21-30 Published: SEP 2007
Publication 5	Changes in atmospheric corrosion rate caused by chloride ions depending on rain regime Corvo, F; Minotas, J Minotas; Delgado, J ; Arroyave, C ; Changes in atmospheric corrosion rate caused by chloride ions depending on rain regime By: Corvo, F; Minotas, J; Delgado, J; et al. ; CORROSION SCIENCE Volume: 47 Issue: 4 Pages: 883-892 Published: APR 2005

Partner University: Other Research group members

How many other members of the research group are expected to be involved in the mobility (from the Partner University to Politecnico di Torino)? 2 [3]

Partner University: Second member of the research group involved in the mobility

Name John
Surname Rios
Academic position Ph.D
Department Antonio Nariño University

Partner University: Third member of the research group involved in the mobility

Name Julieth
Surname Mejia
Academic position Ph.D
Department Antonio Narino University

Description of the project

Project objectives	The objectives of the proposal are the following: 1.Development of joint research activities on atmospheric corrosion monitoring outdoor and indoor by means of innovative smart technologies 2.Development of joint education activities by means of training courses in Italy and Colombia on atmospheric corrosion control and monitoring, a summer school organization in Colombia, title: "Sustainable methodologies for corrosion prevention", 3. Development of actions of co-operation for solving specific conservation problems related to the moving, management, exhibition and storage of metal ancient collections with the choice of safe environmental conservation conditions and materials. 4. Preliminary activities for the establishment of a Research Agreement and of a Students Exchange Agreement between the research groups of the two partner universities. 5. To increase the knowledge and encourage sharing of each partner capabilities, information and experience by means of the organisation of a thematic workshop in Torino, title: "Italian-Colombian joint workshop on corrosion science and engineering: contribution to cultural heritage safeguard"
Project duration (months)	12
Overall description of the	The following activities will be carried out: 1.Development of joint

research activity that Politecnico di Torino and the Partner University intend to carry out.

research activities on atmospheric corrosion monitoring outdoor and indoor by means of innovative smart technologies. The aim is to develop a highly sensitive and innovative methodology for evaluating the safety level of outdoor and indoor areas with respect to metallic artifacts conservation conditions. A set of copper, silver, iron samples will be coated with a nanostructured Cu, Ag and Fe thin film, in order to obtain reference specimens characterized by higher corrosion susceptibility, which should allow to assess the environmental aggressivity in short-time. The relative humidity (RH%) and temperature (T) differences from point to point, inducing different corrosion rates of the metallic artifacts will be assessed with a multi-point monitoring system that will be employed to measure RH% and T in different points indoor and outdoor. The system is based on a network of small autonomous smart sensors, which record T and RH and send the results to an external personal computer, thus allowing a continuous non-invasive monitoring. Two test environments outdoor and two indoor will be selected in both countries by the two participating institutions, involved long time in atmospheric corrosion as well as Cultural Heritage safeguard projects. The potential of this cooperation is to grow into broader exchange opportunities both for the development of new sustainable procedures beneficial for all the conservation and restoration community and for the creation of partnered student internships and the development of an international curriculum. 2. Development of joint education activities by means of training courses in Italy and Colombia on atmospheric corrosion control and monitoring, a summer school organization in Colombia, title: "Sustainable methodologies for corrosion prevention", 3. Development of actions of co-operation for solving specific conservation problems related to the moving, management, exhibition and storage of metal ancient collections with the choice of safe environmental conservation conditions and materials. 4. Preliminary activities for the establishment of a Research Agreement and of a Students Exchange Agreement between the research groups of the two partner universities 5. To increase the knowledge and encourage sharing of each partner capabilities, information and experience by means of the organisation of a thematic workshops organization in Colombia, title: "Italian-Colombian joint workshop on corrosion engineering"

Description of the activities already developed with the Partner University, if any

Cooperation in the field of corrosion science engineering due to the common back-ground of the researchers involved in the proposal, who are involved in the International Corrosion Council (ICC), an international association that consists of representatives of countries interested in increasing the benefits to be derived from the advancement of corrosion science and engineering, and to stimulate internationally research in corrosion science and engineering and to encourage broad dissemination of the results, to promote cooperation and friendship among and between corrosion scientists and engineers in every countries, to foster the practical application of research results through education. Prof. Carlos Arroyave is the President of ICC and Prof. Emma Angelini is II Vice-President.

Description of the project: incoming and outgoing mobility

Emma Angelini: estimated duration of the mobility (total number of months, considering all mobilities) 3

Marco Sangermano: estimated duration of the mobility (total number of months, considering 3

all mobilities)

Sabrina Grassini: estimated
duration of the mobility (total
number of months, considering
all mobilities) 3

Elisabetta Di Francia:
estimated duration of the
mobility (total number of
months, considering all
mobilities) 3

Carlos Arroyave : estimated
duration of the mobility (total
number of months, considering
all mobilities) 2

John Rios: estimated duration
of the mobility (total number
of months, considering all
mobilities) 2

Julieth Mejia: estimated
duration of the mobility (total
number of months, considering
all mobilities) 2

total number of months: 18

Notes

Description of the project: have you already planned the mobility period of Emma Angelini?

First period estimated from: 01/03/2017

First period estimated to: 30/04/2017

Second period estimated from: 01/07/2017

Second period estimated to: 30/07/2017

Third period estimated from:

Third period estimated to:

Description of the project: have you already planned the mobility period of Marco Sangermano?

First period estimated from: 01/03/2017

First period estimated to: 30/04/2017

Second period estimated from: 01/07/2017

Second period estimated to: 30/07/2017

Third period estimated from:

Third period estimated to:

Description of the project: have you already planned the mobility period of Sabrina Grassini?

First period estimated from: 01/03/2017

First period estimated to: 30/04/2017

Second period estimated from: 01/07/2017

Second period estimated to: 30/07/2017

Third period estimated from:

Third period estimated to:

Description of the project: have you already planned the mobility period of Elisabetta Di Francia?

First period estimated from: 01/03/2017

First period estimated to: 30/04/2017

Second period estimated from: 01/07/2017

Second period estimated to: 30/07/2017

Third period estimated from:

Third period estimated to:

Description of the project: have you already planned the mobility period of Carlos Arroyave ?

First period estimated from: 01/10/2016

First period estimated to: 30/10/2016

Second period estimated from: 01/05/2017

Second period estimated to: 30/05/2017

Third period estimated from:

Third period estimated to:

Description of the project: have you already planned the mobility period of John Rios?

First period estimated from: 01/10/2016

First period estimated to: 30/11/2016

Second period estimated from:

Second period estimated to:

Description of the project: have you already planned the mobility period of Julieth Mejia?

First period estimated from: 01/10/2016

First period estimated to: 30/11/2016

Second period estimated from:

Second period estimated to:

Description of the project

Describe the event addressed to research staff and/or to PhD students and/or external subjects you intend to jointly organize with the partner University

Other activities

A 3 days “Italian-Colombian joint workshop on corrosion science and engineering: contribution to cultural heritage safeguard” will be organized in Italy. The workshop will be a satellite event of the IEEE I2MTC Instrumentation and Measurement Technology Conference that will be organized by the researcher of Politecnico di Torino on May 2017. The IMTC conference is focuses on research, development and applications in the field of instrumentation and measurement science and technology. The conference also includes Industrial Tracks reflecting current opportunities for the mutually beneficial fusion of basic research and industrial applications. The field of corrosion engineering, valorisation, characterisation and preservation of Cultural Heritage is deeply related to the metrology issues for the collection, interpretation and validation of data collected with the different analytical, physical-chemical, mechanical techniques, digital technologies, new ICT tools, etc... The workshop program is conceived to foster exchanges of ideas and information, make connections and collaborations, update innovation on “measurements” for Cultural Heritage among material scientists, chemists, physicists, engineers, archaeologists, conservators, restorers, etc.. In detail the main topics will be: - Measurement techniques for studying the corrosion behaviour of metallic artefacts - Non-invasive diagnostic techniques for in situ measurements and long-time monitoring - Eco-friendly and sustainable methodologies for preventive conservation - Measurements and sensors for environmental monitoring. Taking advantage of this international and wide audience, the workshop intends, therefore, to contribute to the diffusion of knowledge, experience and methodologies dealing with corrosion engineering and cultural heritage safeguard.

The implementation of the project is based on the transfer of knowledge and experience in the area of conservation of metallic artefacts indoor and outdoor, consequently a one week summer school will be organized in Colombia on July 2017, title: “Sustainable methodologies for corrosion prevention”. The summer school is addressed both to the student and to a wider audience, presenting

Project sustainability

general, important problems concerning cultural heritage preservation, mainly focused on tangible metallic cultural heritage. - Presented problems: . what does sustainable conservation mean ? . standards, regulation and ethical issues in conservation . corrosion mechanisms of metallic artifacts . advanced analytical tools . conservation materials and processes . sustainable moving and management of artefacts . sustainable exhibition and storage of artefacts Activities mainly addressed to PhD students. . Environmental monitoring and corrosion tests strategy development . Development of the test plans, carrying out of the tests . Analysis and interpretation of the test results in the areas of chemical and micro-structural characterization, conservation effectiveness and corrosion resistance An additional knowledge transfer will be reached because this summer school will provide the opportunity to acquire knowledge not strictly related to the scientific research work focused on: . skills in the organisation and management of international events dedicated to Cultural Heritage conservation and valorisation; . the ability to work in an international team and to exchange knowledge; . the ability to formulate scientific problems in a clear way – particularly important in multidisciplinary communication.

The impact of the proposal will last after the end of the project. Conservation and valorisation of Cultural Heritage is a fundamental element and an essential mission of every country. Ancient metal artefacts, from iron to precious noble metals objects, are high value objects for their intrinsic historical nature and for the great and sophisticated skill used to produce them. The major problems in stopping degradation and in saving these ancient witnesses are the degradation phenomena and in particular, the corrosion of artefacts that is added to the damage induced by corrosion throughout industries which costs approximately the equivalent to 4% of the gross domestic product (GDP) of the industrialized countries, in term of repair, maintenance and loss of production capacity. In the case of Cultural Heritage the damage is more than economical because it deals also with the lost of witness of the past of mankind and of relevant works of art. The aim of the proposal is to transfer and disseminate experience and knowledge acquired in previous national and international projects aimed to identify the best conservation strategies. With this aim in mind, the project will have a strategic relevance due to the strict interaction of the different interest areas that include information technology, chemistry, archaeology, conservation science and history of art and economy. The approach of the project is based on this philosophy and the co-operation among Italy and Colombia is mandatory in order to integrate different experiences, to transfer and to use of technologies and expertise thus increasing their geographical applicability. The project intends to contribute to the diffusion of knowledge, experience and methodologies dealing with the conservation of metal ancient artefacts. These artefacts are characterised by a wide compositional nature and have been produced via different complex manufacturing techniques that have greatly influenced their chemical and metallurgical stability. Therefore, only on the base of results of specific information and reliably evaluated conservation materials and methods it possible to ensure a long-term stability to these witnesses of the human creativity and skill as well as to manage them for a large fruition and valorisation. The training courses on the development and employment of non-polluting conservation materials with multifunction properties will help to reduce the use of the polluting manufacturing processes. This will improve the work environment of workers and could decrease professional diseases because it can be extended to industrial cases. The exploitation of training courses on the design, production and validation of materials for conservation should have impacts on

employment. New processes will require some new competencies in manufacturing and can develop new production methods and induce competitive products and services. The use of new environmentally friendly materials and methods for conservation will not produce effluent waste to be treated, will replace others process which have some problems to meet the new environmental regulations. Disseminating experience and information could increase the use of environmentally friendly materials for conservation and could help to reduce the use of the polluting manufacturing processes. The establishment of a permanent conservation alliance, in the frame of the International Corrosion Council that will last after the end of the project, will provide and promote opportunity also to other Countries to participate in scientific exchanges at an international level.

Budget: Outgoing mobility costs

Travel costs	3600
Visa	250

Subsistence: Daily lump sum allowance (max 77,47€/day, tax free, including food, accommodation and local transportation)	20990
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Subsistence: Real costs reimbursement on the basis of supporting documents

Budget: Incoming mobility costs

Travel costs	2400
Visa	250

Subsistence: Daily lump sum allowance (max 77,47€/day, tax free, including food, accommodation and local transportation)	13993
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Subsistence: Real costs reimbursement on the basis of supporting documents

Budget: Costs related to the planned activities

Costs for events addressed to research staff and/or to PhD students and/or external subjects (compulsory activity)	2017
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Joint publication costs	500
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Costs for the participation in conferences for the dissemination of the project results (enrolment fees, travel, food and accommodation, etc) (max 10% of the total budget)	1500
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Costs for the organization of summer/winter schools (Teaching material, dissemination, room rent, caterer, etc)	4500
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Please describe here the costs related to organization of summer/winter schools

Other costs

TOTAL: € 50000

Required documents

Curriculum Vitae of the Applicant	CV_Angelini _2016.pdf (272KB) CV applicant Italy
filecount - Curriculum Vitae of the Applicant	1
Curriculum Vitae of the Partner coordinator	CV_CarlosArroyave_2015_09_06-2.pdf (103KB) CV partner colombia
filecount - Curriculum Vitae of the Partner coordinator	1
Endorsement letter	letter_endorsement_2016_06_16.pdf (265KB) Endorsement letter Colombia
filecount - Endorsement letter	1
Endorsement letter of the Head of the Department	Letter_Head_Department.pdf (96KB) Letter Head Department
filecount - Endorsement letter of the Head of the Department	1