SAFEJOINT

Enhancing structural efficiency through novel dissimilar material joining techniques

newrail

National Technical University of Athens

ita

CAF

swerea IVF

Fraunhofer IFAM

swerea SICOMP

KAUNO TECHNOLOGIJOS UNIVERSITETAS

SEVENTH FRAMEWORK PROGRAMME

JOINING SUB-PLATFORM TO MANUFUTURE
1st General Assembly Stakeholder Meeting
28th November 2013

Dr. Elias Koumoulos, NTUA

1 Concept & Objectives

2 Project Overview

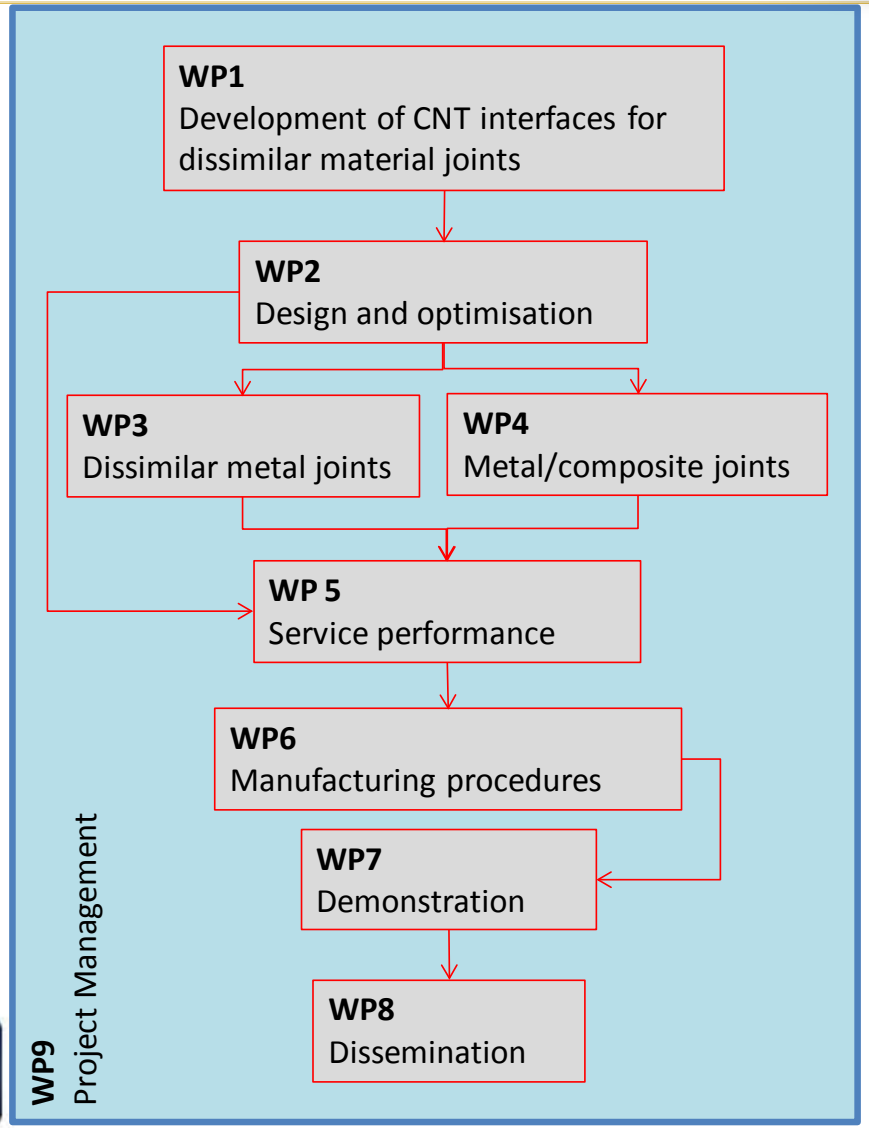
1 CONCEPT & OBJECTIVES

- Due to the different chemical, mechanical and thermal behaviours of materials, dissimilar material joining presents challenges significantly different than those for similar materials.
- Joining of dissimilar materials is not a new concept, but structural applications remain limited.
- Innovations in nanomaterial technologies have opened possibilities for the implementation of both dissimilar metal joints, as well as metal/composite bonded joints with higher bond strength than is currently available.

1 CONCEPT & OBJECTIVES

- *The overall objective of SAFEJOINT is*
  - *to develop technologies for the design and manufacture of innovative lightweight metal to metal and metal to composite joints utilising the unique characteristic properties of specially tailored nanomaterials introduced at the joint interfacial region and also*
  - *put in place the methodologies necessary for reliable through life inspection of their integrity thus maximising the industrial impact of the results of the research work.*

2 PROJECT OVERVIEW

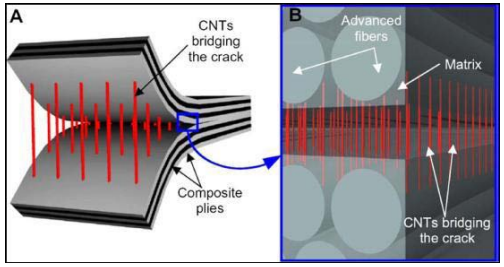


Industry Advisory Group

Bombardier
Alstom
Airbus
ARCAM
WTR (offshore)

2 PROJECT OVERVIEW

- WP1 Development of CNT interfaces for dissimilar material joining
  - This workpackage will define and characterise the nanocomposite joint interface (or interphase) and the technologies for the application of nanoparticles to create strong transition joints for both metal/metal and metal/composite joints,
  - benchmark any existing dissimilar joining techniques, define the types of joints that are applicable to structural applications and rank them in terms of fabrication cost, ease of maintenance, inspection regime and industrial impact.
  - define and classify defects which can occur in metal/metal and metal/composite joints (define critical defect sizes, the types and locations), which have to be detected using the NDE techniques developed during this project.
- WP2 Design and Optimisation
  - The main objective of this work will be to undertake a detailed study of joint design and optimise the performance of the developed joints under service loads.
- WP3 Manufacture of dissimilar metal joints
  - The main objective of this work will be to undertake the manufacture of the metal/metal joints using nanoparticle fillers.



2 PROJECT OVERVIEW

- WP4 Manufacture of metal/ composite joints
  - The objective of this work package is to undertake the manufacture of the metal /composite joints addressed in the project and through the optimisation process develop the manufacturing procedures for such joints
- WP5 Joint integrity assessment
  - The main aim is to assess the short and long term integrity of dissimilar material joints in terms of their mechanical (strength, fatigue, impact) and environmental performance (corrosion). Based on the results, a design optimisation of the novel proposed joints will be carried out simultaneously with appropriate quality control techniques, using newly developed NDT and NDE techniques.
- WP6 Manufacturing procedures
  - This WP will produce detailed manufacturing guidelines for the preparation of dissimilar material joints (both metal/metal and metal/composite) exhibiting optimum performance, as well as details of the inspection procedures for quality control and through service life assessment.
- WP7 Demonstration
  - This WP will undertake the demonstration activities of SAFEJOINT to ensure that the technologies developed in the laboratory can be transferred in the field.
- WP8 Dissemination
  - This WP will undertake the activities to disseminate the output of the SAFEJOINT project, raise awareness in the European Industry of the novel joints and joining techniques developed in this project.

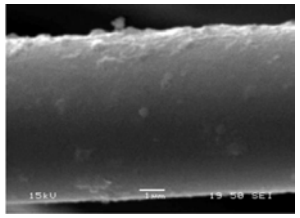
PROJECT OVERVIEW

- Metal/composite joints
  - Several techniques for the enhancement of metal/composite joint strength are undertaken
    - Electrophoretic deposition (EPD) of CNTs
    - Graded adhesives
    - CNT dispersions in epoxy adhesives
    - CNT thin veils

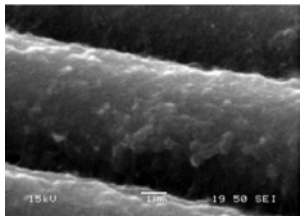
2 PROJECT OVERVIEW

- **EPD** of MWNTs on carbon fibre mat for different deposition time duration show an optimum deposition after 4min.
- Long exposure (≥1hr) exposure leads to a breakdown and agglomeration of MWNTs on preferential sites on the fibre
- **Thin veils** are produced from CNT filled thermoplastic fibre to be introduced at the inteface between metal and composite

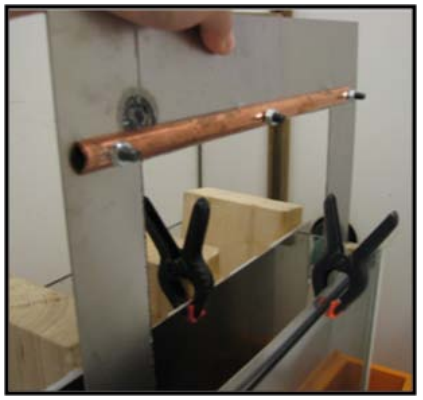
SEM (on annealed treated CFs which are free of epoxy sizing)



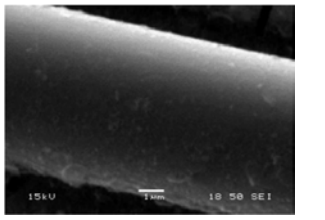
20V/25mm/1min/0,05 wt%



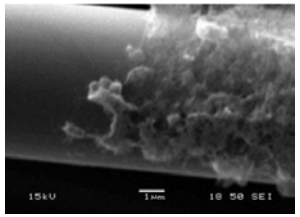
20V/25mm/4min/0,05wt%



EPD on CF mat

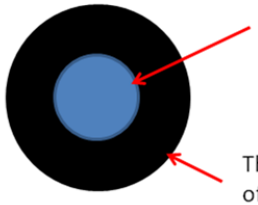


20V/25mm/1h/0,005wt%



20V/25mm/2h/0,005wt%





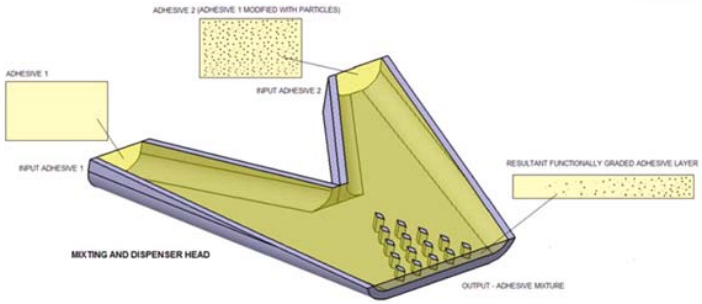
Weight ratio of PA core is 47 wt% in bicomponent fiber.

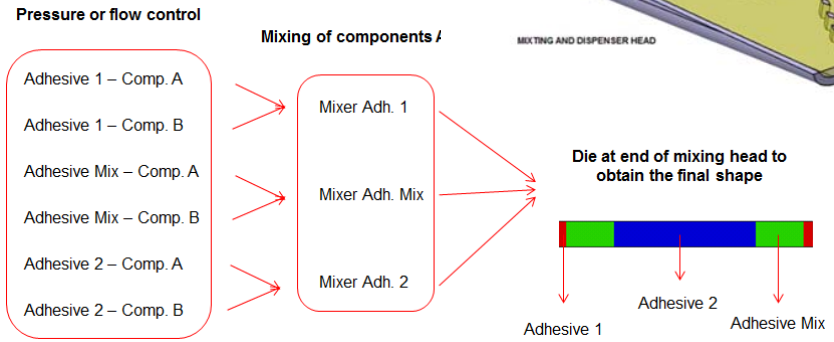
The Sheath is PVDF with 3 wt% of CNT and its weight ratio in the bicompoent fiber is 53 wt% .

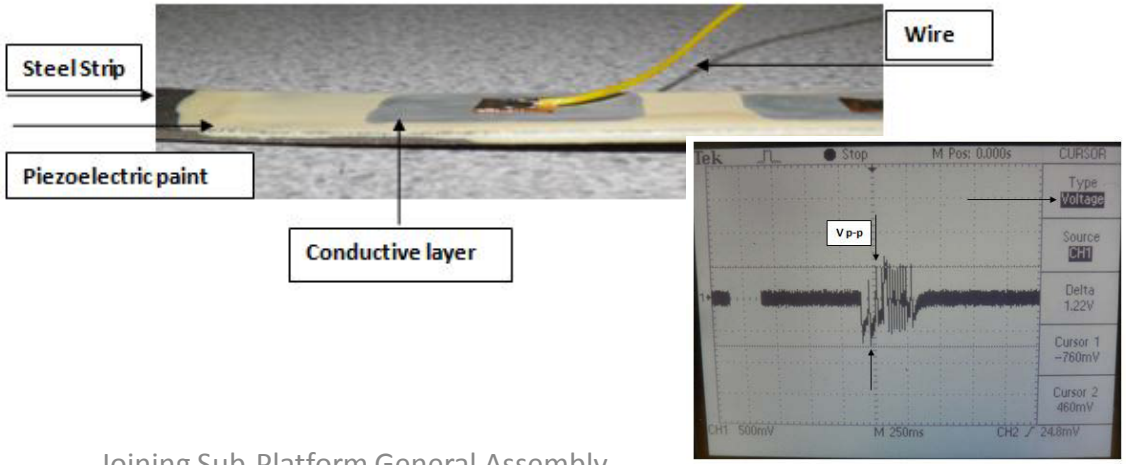
The CNT in bicomponent fiber is 1.59 wt% (3 wt% X 53 wt%= 1.59 wt%)

2 PROJECT OVERVIEW

- **Graded adhesives** will be used in lap joints (with and without CNTs) to vary the adhesive strength along the joint and reduce premature failures through peel stresses
- **Piezoelectric paints** are being developed, to be introduced into the joint to provide quantitative data of the stress distribution along the joint interface.







2 PROJECT OVERVIEW

- **Metal to metal joints**

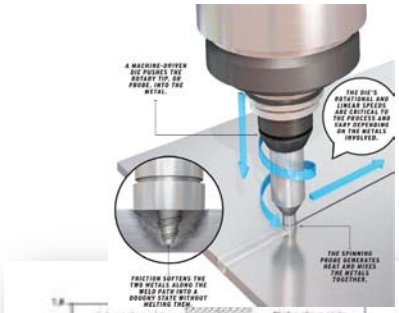
Friction Stir welding process
Alloys: AA5083-AA6082
Fillers: (Al_2O_3, SiC, TiC, CNTs)
Corrosion inhibitors

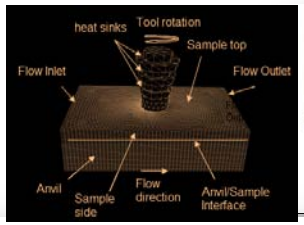
- **Properties**

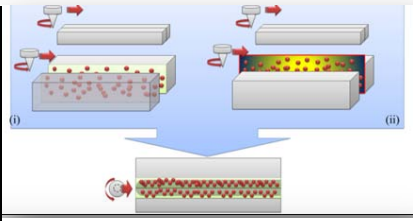
Mechanical properties
Plastic deformation
SEM, structure
Nanomechanical properties
Nanoscale deformation
Corrosion, AFM

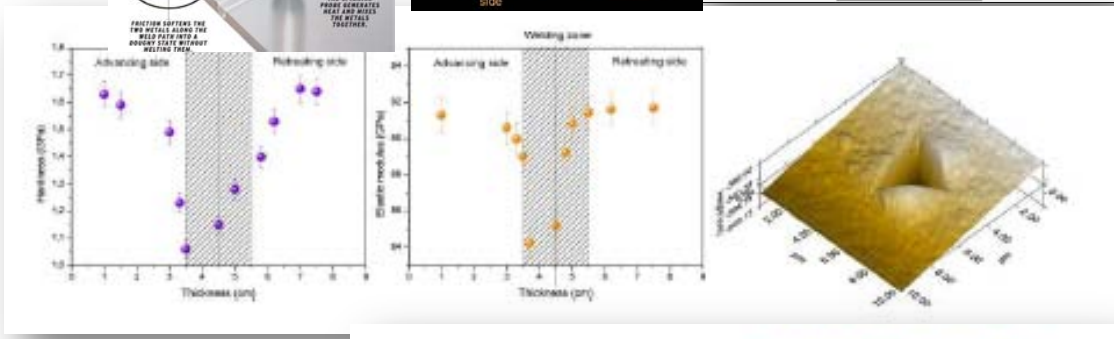
- **Modelling**

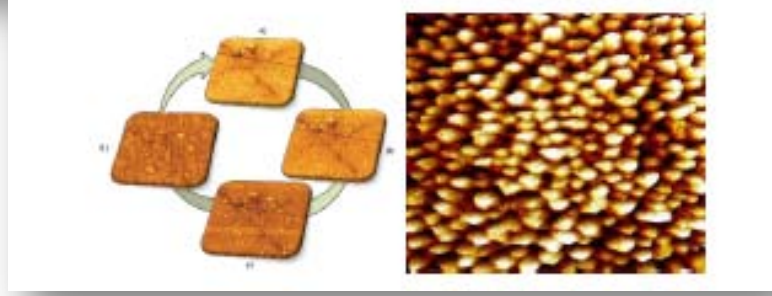
Optimisation
FE of FSW
Design











Thank you

www.safejoint.net

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