

Contracts and Projects

Main international research programs

BE97-4650: MANUFACTURE OF DUAL ALLOY TURBINE ENGINE DISKS (MANDATE)

Project duration: July 1998 – December 2002

Partners: AAP (UK), EC-JRC-IAM (EC), TUR (DE), Aubert-Duval (FR), Tecphy (FR), Bodycote (UK), Armines (FR), BAM (DE), CEA/CEREM (FR), DERA (UK), EMPA (CH)

Objectives: a gas turbine disk manufacturing, to combine a creep resistant alloy for the rim, with a high fatigue/tensile strength material for the bore, to produce significant operation temperature gain.

IENI-Mi activity: A contribution in demonstrating the ability of existing joining and post-manufacturing heat treatment routes for realizing the desired bi-metallic gas turbine disk structures. Tensile and creep properties measurement of base alloys and the bi-metal combinations. Metallography and fractography studies of laboratory specimens post mortem.

EC Concerted Action COST522: ULTRA-EFFICIENT, LOW EMISSION POWER PLANT INTO THE 21ST CENTURY

The European Action is divided into three Working Groups: Steam Power Plant (covering steam turbines and boilers), Gas Turbine (covering small industrial, heavy duty and aeroderivative gas turbines) and Plant Integration and Ancillary Component (covering novel power plant components, fire-side materials and plant issues). IENI-Mi has contributed with the following two projects in the Gas Turbine Group:

WP 1.1 Blades and Vanes: High Temperature Mechanical Properties of Nickel-base Superalloys for Gas Turbine Blades, Project n° I 102.

Project duration: 1999-2003

Partners: ABB ALSTOM (UK), HOWMET (UK), AGH (PL), FZJ (D), IPM (CZ), Tampere University (FL), TUK (SL), NTUA (GR), KWU-SIEMENS (D).

IENI-Mi activity: low cycle fatigue, stationary/cyclic creep, and fatigue crack propagation properties determination of a new single crystal nickel base superalloy (SX186). Effect of coatings on the mechanical properties of the alloy in the 700-900°C temperature range.

WP 1.2 Blades and Vanes: Gamma TiAl, Project n° I 101

Project duration: 1999-2003

Partners: ABB (CH), ALSTOM (UK), CSIC (CZ?), DERA (UK), IRC (UK), Tampere University (FL), ITC(I), VOLVO A. C. (S), NLR (NL).

IENI-Mi activity: constant and variable loading creep, low cycle fatigue and fatigue crack propagation tests at temperature up to 800°C in air and in vacuum environment. Optical and electronic microscopy. Correlation between microstructure (duplex, nearly-lamellar, lamellar) and high temperature mechanical properties.

EC 5th FP GROWTH: G5RD-CT-2002-00819: EXPANDING THE LIMITS OF SINGLE CRYSTAL SUPERALLOYS THROUGH SHORT CRACK FRACTURE MECHANICS ANALYSIS (SOCRAX)

Objectives: to complete the knowledge and the analytical/numerical tools in the field of short crack propagation and fracture analysis of single crystals for turbine blades and vanes.

Project duration: December 2002- November 2006

Partners: Ecole Nationale Supérieure des Mines (F), Imperial College of Science, Technology and Medicine (UK), Institute of Mechanics of Materials and Geostrutures (Gr), Federal Institute for

Materials (D), SNECMA (F), MTU (D), SIEMENS (D).

IENI-Mi activity The fatigue crack propagation and the creep behaviour of the single crystal (SX) nickel base superalloy PWA 1483 has been studied at high temperatures ($\leq 950^{\circ}\text{C}$) on $\langle 001 \rangle$ and $\langle 111 \rangle$ oriented specimens. The experimental results have been correlated with the specimens orientations and the microstructure evolution.

EC Concerted Action COST 538: HIGH TEMPERATURE PLANT LIFETIME EXTENSION

Objectives: to develop an innovative “integrated toolbox” of predictive methods/models and targeted invasive and non-invasive measurements techniques, improving the means for European industries to reliably quantify the condition and remaining life of plant components in all types of conventional fossil, biomass and waste-fired power plant.

Project duration: 2004 - 2008

Partners: Cranfield University (UK), Alstom (CH, UK), Siemens (UK), BAM (D), Plansee (A), QinetiQ (UK), NPL (UK), Ansaldo Energia (I), CISE (I) ..., >30 partners.

IENI-Mi activity: creep and microstructure studies of IN 738 LC and CMSX4 SX for blades and Haynes 230 Ni-base superalloy for combustion chambers.

EC 6th FP IP IMPRESS – NMP3: INTERMETALLIC MATERIALS PROCESSING IN RELATION TO EARTH AND SPACE SOLIDIFICATION (IMPRESS).

Project duration: 2004 – 2009

Partners: ESA (EU), Rolls-Royce (UK), ACCESS (D), IMSAS (SL), ... >40 partners.

IENI-Mi activity: Mechanical properties (tensile, creep, low cycle fatigue and creep and fatigue crack propagation) evaluation and creep damage modelling of TiAlNb compound and a new TiAlTa intermetallic compound for light gas turbine blades. Microstructure and fractography analyses in order to understand and rationalize the alloy behavior at elevated temperature. Development of a physically based constitutive equation able to describe the high temperature mechanical behavior of the studied alloys.

Main national research programmes

ANSALDO ENERGIA contract (2010-12): CREEP BEHAVIOUR OF A TURBINE DISK ALLOY.

Objectives: to measure the mechanical properties of a disk turbine alloy.

Project duration: 2010- 2012

IENI-Mi activity: Creep properties determination of a turbine disk alloy.

ANSALDO ENERGIA contract (2005-09): PANDA – CREEP, TMF AND LCF STUDIES OF RENE’ 80 Ni-BASE SUPERALLOY FOR ADVANCED GAS TURBINE BLADE.

Objectives: to utilize new alloys for blades of land based gas turbines to increase their efficiency and performance.

Project duration: 2005-2009

IENI-Mi activity: low cycle fatigue, thermal fatigue, creep properties determination of the nickel base superalloy René80. Develop a new physically based constitutive equation able to describe the creep behavior of the studied alloy and simple enough to be utilized in finite elements computer programs.

AVIO SpA contract (2005-08): TENSILE, CREEP, LCF AND MICROSTRUCTURE STUDIES OF HAYNES 230 Ni-BASE SUPERALLOY.

Objectives: to develop new lifing model for combustion chamber of AVIO-SNECMA engine to be used for Suhoi regional aircraft.

Project duration: 2006-2008

Partners: CSM (Roma)

IENI-Mi activity: low cycle fatigue, thermal fatigue, creep, tensile properties determination of the nickel base superalloy Haynes 230.

EMA SpA contracts

FAR MITGEA: CREEP BEHAVIOUR ANALYSIS OF THE NICKEL BASE SUPERALLOY CMSX 486.

Project duration: 2006-2010

IENI-Mi activity: creep characterization of the superalloy CMSX486 in the temperature range 850-1000°C and stresses to produce time to rupture up to 10,000 h.

FIRB MITGEA contract RBIP064N2X: STUDY OF NEW MATERIALS FOR GAS TURBINES OF VERY HIGH EFFICIENCY AND REDUCED ENVIRONMENTAL IMPACT.

Objectives: to define innovative solutions for the production of components for high-performance gas turbine by studying innovative materials.

Project duration: 2007-2011

Partners: CNR-IENI Ge, EMA, Ansaldo Energia, Ansaldo Ricerche, ENEA, Genoa University

IENI-Mi activity:

to correlate the mechanical behaviour of the nickel base superalloy CMSX486 to the microstructure,

to determine the main damage mechanisms for stresses/temperatures similar to those found in component during service

to analyse the microstructure/mechanical properties in terms of the heat treatment of a new TiAlNb Intermetallic alloy.

Mangiarotti Nuclear contract (2010-12): RESIDUAL STRESS ASSESSMENT THROUGH XRD TECHNIQUES.

Objectives: to measure the residual stresses through XRD techniques in Alloy 690TT tubes for thermal exchangers in nuclear plants.

Project duration: 2010-2011

IENI-Mi activity: XRD measurements on Alloy 690TT tubes.