About ICARUS

ICARUS, an ambitious synergy of European organizations, seeks to introduce a **novel thermodynamic methodology** considered towards identifying the elements and the relative chemical composition necessary for enabling a nanocrystalline (nc) state to occupy a **relative minimum of the Gibbs free energy**, thus achieving **reasonable stable nanostructure against coarsening.**

This approach is integrated with multiscale and thermodynamic (Nano-Calphad) modeling, in order to implement a High-Throughput Screening tool which will open a **new horizon for the exploration of multinary thermal stable nanocrystalline alloys,** exhibiting **superb tailored properties.**

The project is funded under the EU Framework Programme for Research and Innovation (Horizon H2020) as a **Future and Emerging Technologies (FET)** action. Results arising from ICARUS will be materialized in specific demo compounds, representative of carefully selected new alloys families that **will change the present paradigm of the European aerospace industry.** The most promising nanocrystallyne material identified will be synthesized by mechanical alloying and physical vapor deposition, and the obtained samples will be characterized with regards to their applicability in the aerospace sector.

A proof of concept will be given and tested by experts and specialized industries working in the aerospace sector in close contact with **NASA** and **ESA**.

In particular, ICARUS will demonstrate its potential by producing **innovative coarsening-resistant nanocrystalline alloys with enhanced radiation tolerance** (based on refractory metals), and **light-weight high strength** (based on Al, Mg, Ti) alloys.

Consortium

Community contribution:	€ 2,698,062.50
Start Date:	September 1st, 2016
Duration:	36 months
Coordinator:	Universidad de Burgos-ICCRAM
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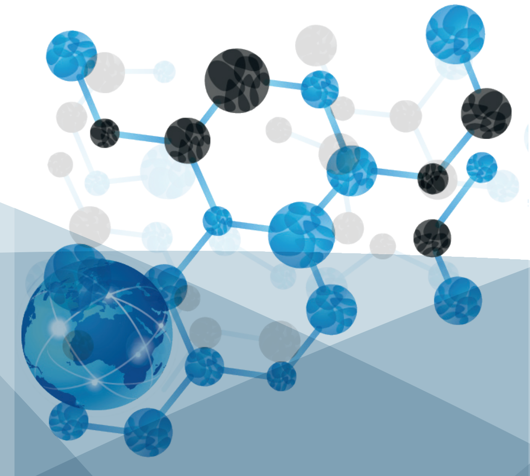
http://icarus-alloys.eu/

Design by EASN-TIS

ICARUS



Innovative Coarsening-resistant Alloys with enhanced Radiation tolerance and Ultra-fine grained Structure for aerospace application

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 713514.

Objectives

ICARUS has three main objectives:

- To **develop the conceptual framework** necessary to design thermodynamically stable multi-component nc metal alloys resistant to coarsening;
- To **validate the statistical thermodynamic modeling** by matching numerical simulation with experimental evidence;
- To **provide a proof of concept** by fabricating selected thermodynamically stable multi-component nc metal alloys resistant to coarsening of interest for specific aerospace applications.

To achieve these goals, ICARUS fosters a three-fold multidisciplinary strategy:

- **Thermodynamic modeling** to describe chemical composition and atomic species distribution in both crystalline grains and intergranular disordered interfaces;
- The **validation** of the thermodynamic model performed on suitable selected test systems;
- The **fabrication** of thermodynamically stable multi-component nc metal alloys resistant to coarsening and specifically addressed to meet the materials demand of aerospace, aeronautical and turbine industry. This will be achieved by assessing the needs of various potential user groups and by involving stakeholders from future application fields in the ICARUS Advisory Board.

Methodology

WP 1: Ethics

WP2: Management & Coordination

WP3: Modeling Materials by Design

Effort for new thermodynamically stable multicomponent nanocrystalline metal alloys

WP4: Synthesis Identification & Fabrication

of binary and multinary alloys as radically new materials solution for extreme-conditions aerospace applications

Molecular Dynamics + Density Funcational Theory Information for Refinement

Thermodynamic Model

Nano - Calphad Approach

Refinement

WP5: Specific Aerospace Tests

Physicochemical, structural and mechanical characterization of the alloys.
Specific performance tests under extreme operating conditions

TRL 3-4

WP6: Exploitation, Dissemination, Communication

Communication & Training early stage students

Roadmap towards Industrial Exploitation

Plan for TRL 5

Target Properties

Enhanced radiation resistance by self-healing mechanisms, aimed at withstanding the extreme conditions undergone by materials exposed to cosmic radiation, at lengthening the life cycle of aerospace materials and microelectronics, and at protecting the health status of human beings in manned spacecraft missions

Enhanced thermal resistance, aimed at enabling stable performances under high-temperature conditions, high heat conduction and low thermal expansion, and at enhancing materials performances in dynamic thermal environments with temperature varying approximately in the range from -80 and 100 °C

High mechanical strength to reduce the total weight associated with structural materials, keeping mechanical performances unchanged, which results in lighter construction elements and directly lower fuel consumption in aerospace industry.