TGS6: Physical metallurgy and design of new generic steel grades

Panorámica y oportunidades en la Investigación e Innovación Siderúrgica en Europa

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PLATAFORMA TECNOLÓGICA ESPAÑOLA DEL ACERO

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UNESID Unión de Empresas Siderúrgicas

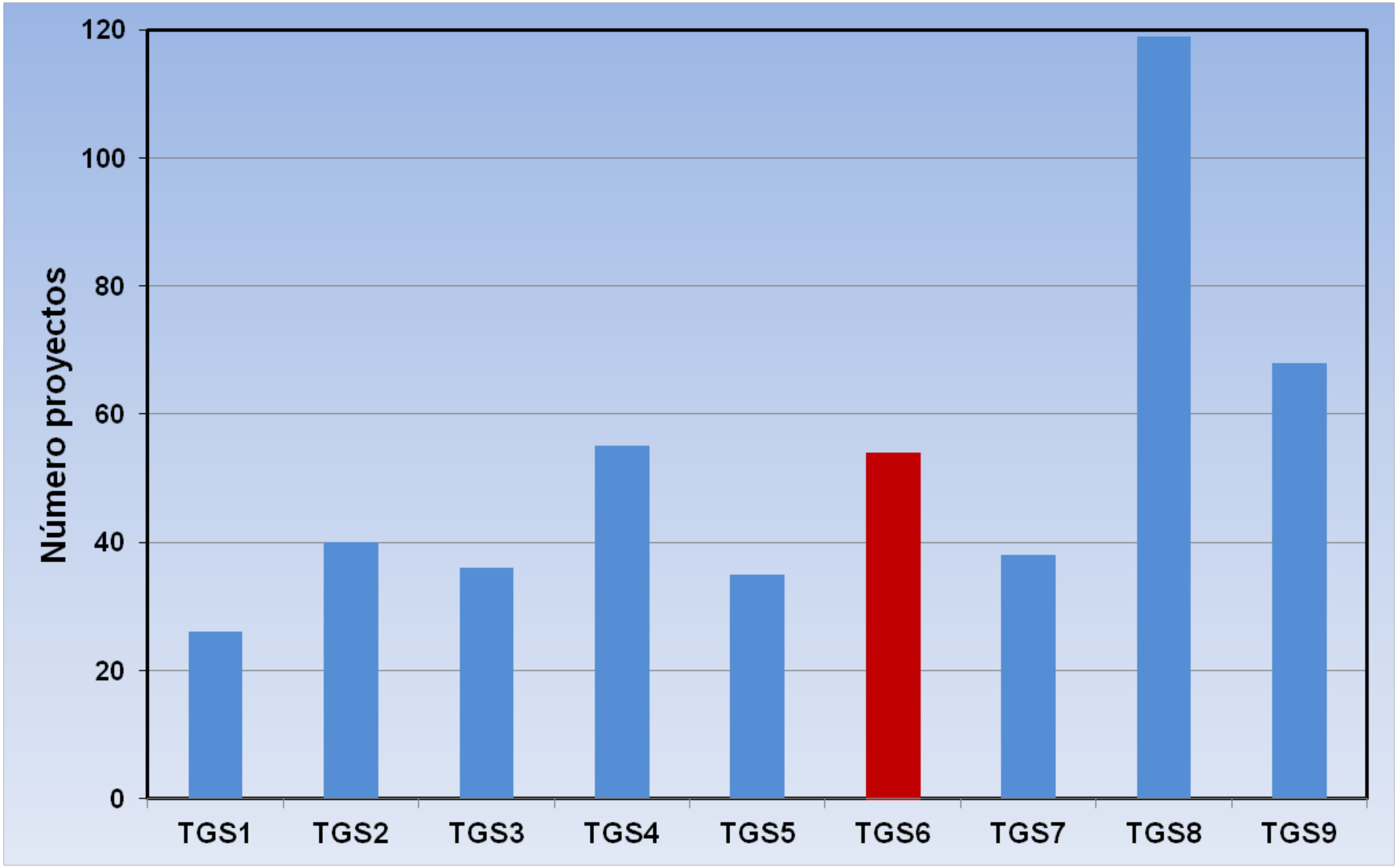
Introducción

- Líneas de investigación-TGS6
- Las cifras 2003-2013
- Evolución de las líneas de investigación
- Tendencias
- Nuevos proyectos: 01/07/2014

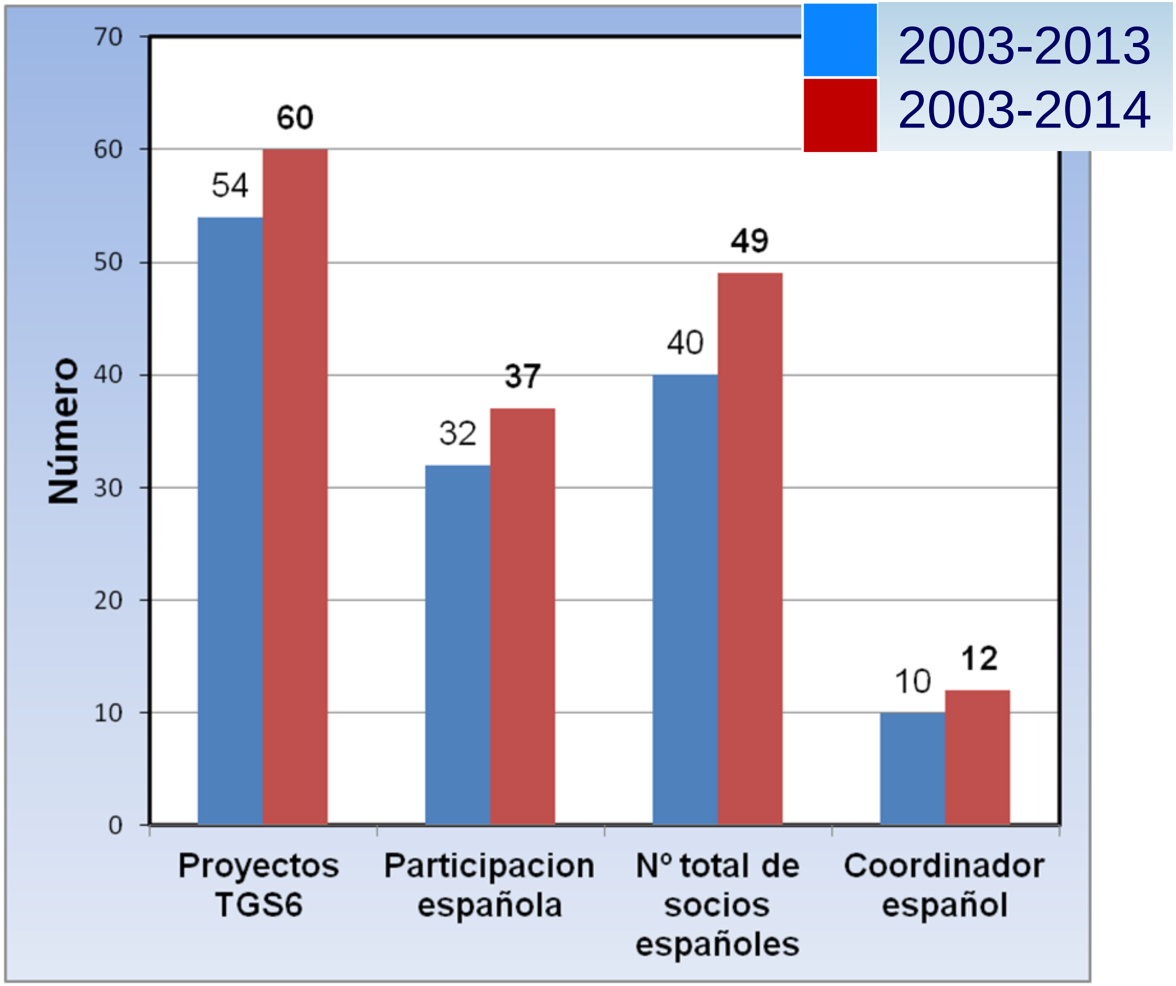
Líneas de investigación-TGS6

- Precipitation, re-crystallisation, microstructure & texture and ageing
- Predictive simulation models on microstructures & mechanical properties
- Development of steel with improved properties at low and high temperatures such as strength and toughness, fatigue, wear, creep and resistance against fracture
- Magnetic properties
- New steel grades for demanding applications
- Standardisation of testing and evaluation methods

Las cifras 2003 – 2013

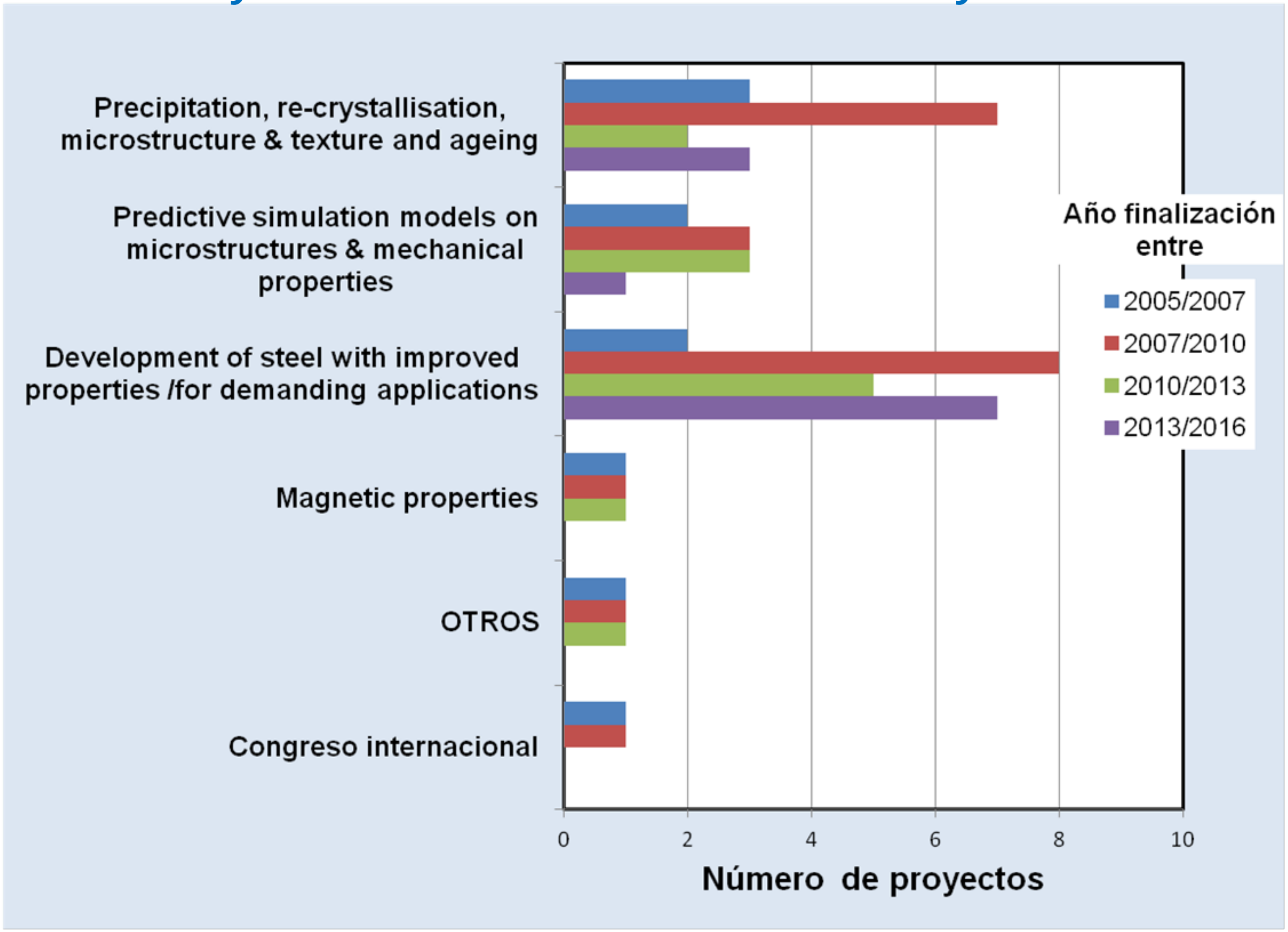


Las cifras 2003 – 2013

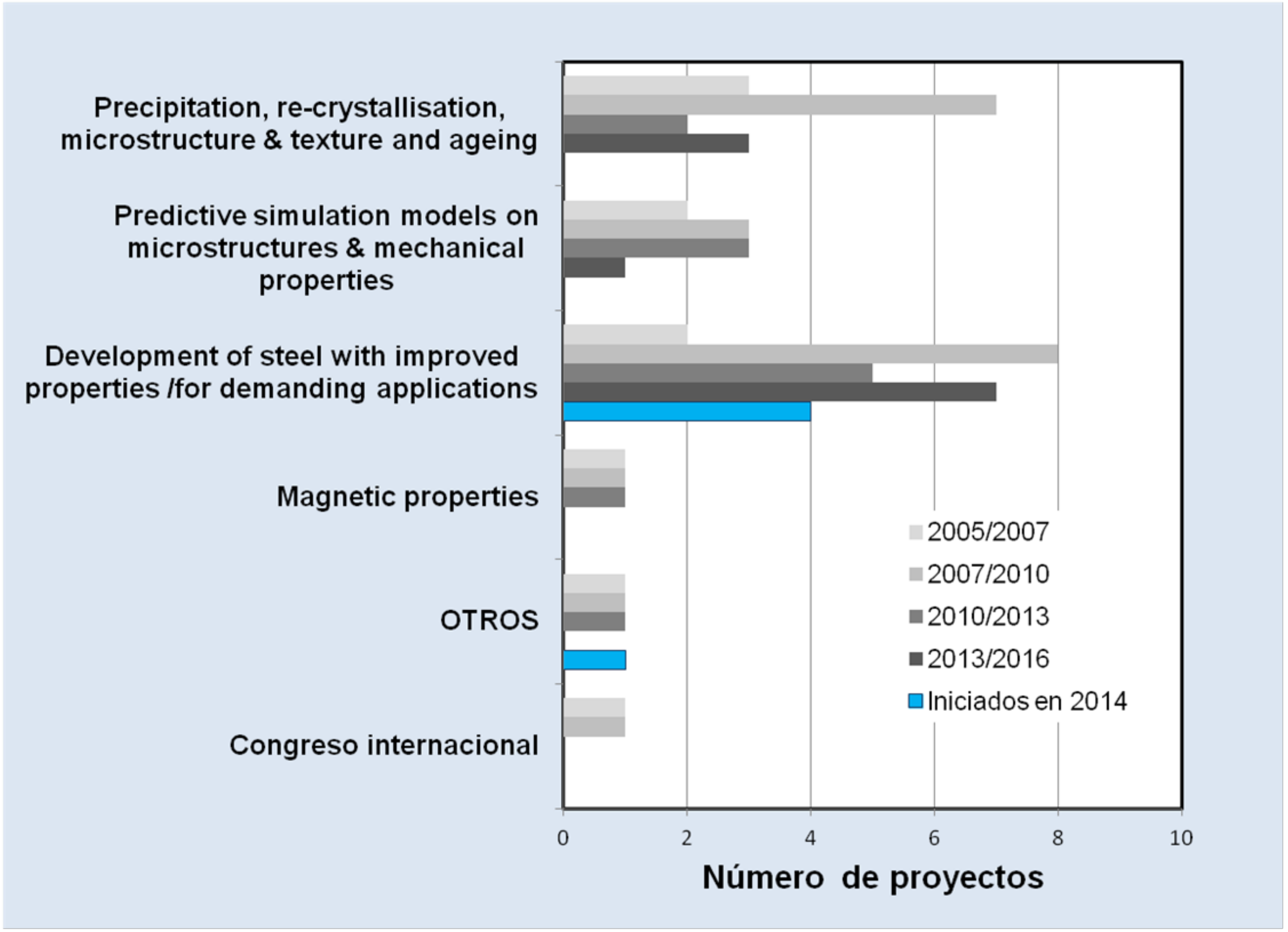


Líneas de investigación por año

Proyectos con inicio entre 2003 y 2013



Tendencias



Precipitation, re-crystallisation, microstructure & texture and ageing
Predictive simulation models on microstructures & mechanical properties
Development of steel with improved properties /for demanding applications
Magnetic properties
OTROS
Congreso internacional
2005/2007
2007/2010
2010/2013
2013/2016
Iniciados en 2014
0
2
4
6
8
10
Número de proyectos

Nuevos proyectos: 01/07/2014

RFSR-CT-2014-00015	**TOUGH-SHEET** *Measurement of toughness in high strength steels sheets to improve material selection in cold forming and crash-resistant components*

Info				
	Type of Project	Research	Duration (months)	36
	Total Budget	1715034 €	Start Date	1/07/2014
	EU Contribution	1029019 €	End Date	30/06/2017

State Running project

Provisional Abstract

The development of lightweight designs and the use of smart materials and manufacturing processes offer the automotive industry a real chance to successfully upgrade the current vehicle standards according to the increasing demands on safety and sustainability. Steel and aluminium already dispute lightweight designs and fibre-reinforced plastics will also be used for structural part soon. But steel still represents the main choice of the total body-in-white, especially since in the two last decades developed the AHSS. The high mechanical strength of such steels makes them especially susceptible to the presence of microcracks, notches or any kind of edge irregularity. Cracks easily nucleate and propagate from these irregularities during the in-life service or after some cold forming steps (in notched areas, around punched or trimmed regions). In both situations, the property that controls crack propagation is the fracture toughness, which cannot be measured in metal sheets with conventional standards because its limited thickness (1-3mm).Thus, steel sheet developer and part manufacturers cannot use this property to design new steel grades, with improved crack tolerance or to adjust forming parameters to prevent crack propagation. Moreover, fracture toughness can also be used to understand crashworthiness of metal sheets and help developing new AHSS grades that allow further gauge reduction. Nowadays, fracture toughness can be readily measured in thin materials through the application of the Essential Work of Fracture (EWF) methodology main used in polymers. Thus the aim of this project is to determine fracture toughness in high strength steels sheets, by means of the EWF methodology, aimed at determining a useful mechanical property to develop failure criteria in sheet metal forming and crash resistant. It is expected that sheet toughness may help to improve material selection in cold forming and to assess crashworthiness of different AHSS for structural components.

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Nuevos proyectos: 01/07/2014

RFSR-CT-2014-00016	**BAINWEAR** *Novel nano-structured bainitic steels for enhanced durability of wear resistant components: microstructural optimisation through simulative wear and field tests*

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1898403 €	Start Date	1/07/2014
	EU Contribution	1139040 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

A novel method for making extremely strong and inexpensive nanocrystalline steels without using severe deformation, rapid heat-treatment or mechanical processing has been recently developed by the formation of nanostructured bainite at very low temperatures (200-300 ºC). It leads to an extremely fine microstructure, consisting in thin plates of ferrite (40-60 nm) and retained austenite (15-30 %). This new generation of steels, referred to as nanobainitic steels, are potentially one of the most significant discoveries in steel metallurgy over the past 10 years.. Nanobainitic grades have shown the highest strength/toughness combinations ever recorded in bainitic steels (2.5 GPa / 30 MPa•m1/2), and also superior potential for wear applications in large components, where a uniform microstructure free from residual stresses or complex processing is required. Nanobainitic steels show a promising and almost unique possibility to optimize both toughness and wear resistance at a reasonable cost. This will open the possibility to substitute other steel grades on applications where very high wear and fracture resistance are required. The aim of the BAINWEAR project is to develop a new family of microstructurally optimised nanobainitic steels with a unique combination of wear resistance and toughness. This will be achieved through comprehensive investigations to fully understand the mechanisms of resistance to different wear modes of nanostructured bainitic steels in terms of the relevant microstructural features such as austenite content, morphology (blocks and films), size and carbon content; and ferrite lath thickness affecting steel hardness.

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Nuevos proyectos: 01/07/2014

RFSR-CT-2014-00017 **BaseForm**

Bainite and second-phase engineering for improved formability

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1750057 €	Start Date	1/07/2014
	EU Contribution	1050033 €	End Date	30/06/2018
State	Running project			

Provisional Abstract

Despite a tremendous development in the past years, the potential of Advanced High-Strength Steels is not yet fully explored. Further optimisation requires a systematic approach combining state-of-the-art experimental characterisation and physically-based model simulations. A lot of work has been dedicated to the correlation between process parameters, bainite microstructure features and specific mechanical properties, but present models can predict only the bainite transformation kinetics during processing and not yet the microstructure morphology. Moreover a microstructure based model to handle bainite mechanical behaviour is still missing. In addition, very little attention has been paid to the impact of the very low volume fraction of martensite or MA islands in the bainitic matrix on the strength and formability. Nevertheless, recent internal results suggested that even a few percentage of martensite can affect strongly the mechanical and damage properties of the bainitic steels. The proposed project focusses on control and optimisation of the very promising combination of steel phases: bainite, martensite and retained austenite. Bainite has since long been known to form a very beneficial matrix structure, which can further be optimised by controlling martensite inclusions for enhanced strength and retained austenite for enhanced formability. By means of experimental characterisation and physical understanding of the evolution of microstructures and the relation between microstructures and mechanical properties, this project will contribute significantly to the further development of this most promising class of Advanced High-Strength Steels. In the current project the microstructure matrix under study will be bainitic, which is a constituent that allows better and more flexible control than martensite and which shows an improved balance of strength and ductility. The bainitic structure will be enriched by both martensite and austenite for optimum properties.

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Nuevos proyectos: 01/07/2014

RFSR-CT-2014-00018	**SteelWind** *Design and development of a new high nitrogen bearing STEEL for offshore WIND turbines with improved surface fatigue, wear and corrosion properties for in service life increment.*

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1892202 €	Start Date	1/07/2014
	EU Contribution	1135317 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

Among the fields of renewable energy sources, the wind energy sector has grown significantly within the last two decades but an actual critical point is the gearboxes life expectancy. Costs associated with their failure rates reach 250 k€ per failure for a 5MW Wind Turbines (WT). The problem is heightened in offshore working. The aim of this proposal is to increase the reliability of WT, improving tribological, fatigue, surface fatigue and corrosion properties of steel bearings modifying chemical composition. 100Cr6 steel is usually used for steel bearings production. On the other hand, it is well-known that nitrogen enhances fatigue strength, wear and fatigue resistance, resistance to crevice corrosion and to pitting corrosion of austenitic steels. Moreover, nitrogen addition helps to refine the microstructure, it increases the strength of the alloy and it can be used instead of nickel as an austenite-forming. The introduction of a new high nitrogen austenitic steel can improve the critical properties of the component and reduces its cost by the increment of the service lifetime. Improvement of the hot/cold workability of the new steel will be moreover valuated as well as the optimisation a Deep Rolling process for steel mechanical surface improvement and fatigue strength enhancement. The chemical composition will be established by alloy design evaluating two production lines (with and without remelting process added to the vacuum induction melting). As consequence cost reduction of steel production will be considered. The new steel composition will be examined by a wide microstructural characterisation and mechanicals testing. Functional test rig will be developed for the evaluation of steel surface fatigue and corrosion properties mainly in offshore application. Industrial melt will be then produced for bearings prototypes manufacturing. They will be validated using full scale tests and in case of damage, mechanisms will be compared with normal failure modes.

		Country	*Scientific person in charge*
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Nuevos proyectos: 01/07/2014

RFSR-CT-2014-00019	**SuperHigh** *In-use properties of Super High strength steels generated by a range of metallurgical strategies*

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1780521 €	Start Date	1/07/2014
	EU Contribution	1068311 €	End Date	30/06/2018
State	Running project			

Provisional Abstract

The overall trend towards increased performance combined with optimized safety, reduced weight and cost effective manufacturing has broadened the interest in super high strength steels (SHSS). Recently, different metallurgical strategies have been proposed for the development of this new generation of hot-rolled SHSS. Many concepts are today only tested at laboratory scale and focused on dedicated applications. For them to become technologically available in a 2015-2020 horizon, a clear link between their in-use properties and potential markets is still missing. This project aims at associating these recently developed innovative microstructures to future production routes and application areas exploiting at maximum their mechanical and in-use properties. Numerous apparent technical solutions on the development of new generation SHSS have been published in the literature, but in most of the cases data are incomplete or unreliable for cross comparison. A full picture of their potential for a wide range of application areas is essential to provide steel makers the guidelines towards the most promising metallurgical routes for their future products in different application areas. This project will use the knowledge of previous research work and further explore the proposed metallurgical routes in a broader perspective. Graphs mapping several mechanical and in-use properties would complement the classical tensile strength versus elongation chart for a large variety of microstructures concepts ranging from TRIP assisted complex phase steels over ausformed martensite and maraging steels until heavy deformed high carbon steels. Those charts will assemble essential information to select the metallurgical routes of super high strength steel (SHSS) for the next decades. The knowledge of previous and running projects will be largely used in our project as most of them have set out the principals of the metallurgy that we consider.

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Nuevos proyectos: 01/07/2014

RFSR-CT-2014-00032 | **CRESTA2**

New Creep Resistant Stable Steel for USC Power Plant

Info	Type of Project	Research	Duration (months)	48
	Total Budget	2588993 €	Start Date	1/07/2014
	EU Contribution	1553393 €	End Date	30/06/2018
State	Running project			

Provisional Abstract

Project targets are know-how consolidation acquired in the CRESTA for the development of microstructurally stable Very High Chromium Martensitic Steels for Advanced Ultra-Super-Critical steels trough longer term and deeper investigations on aged specimens of compositions developed and prototype pipe and welded component realised and further tailoring of the chemical composition of both steel grades. The partnership would like to reach results targeting the EU standard requirements for approval for industrial applications in Advanced USC Power Plants with steam operating temperature in the range of 650-700°C. So far, it has not been possible to obtain sufficient creep strength in 12%Cr steels at temperature of 650°C, simply by strengthening with (V,Nb)N nitrides or addition of boron. Still, more stable coarse Cr(V,Nb)N Z-phase particles form during exposure in expense of finely distributed (V,Nb)N and result in a loss of precipitation strengthening effect and in breakdown of the long-term creep strength. An increased Cr content, to improved oxidation resistance, accelerates this formation of Z-phase nitrides. One approach is to use the more stable Z-phase itself as a strengthening phase and promote precipitation of a finely dispersed precipitation of Z-phase. The second approach is the reduction of the Nb content because this element seems the more critical to accelerate transformation of (V,Nb)N into Z-phase. There is a need for further investigations, without interruption of current activities still running, in order to consolidate so far gained knowledge. Besides, slight changes in compositions are necessary in both steels to improve fabricability (particularly for large scale industrial applications), to optimize the B and N content improving welded joint properties and reducing the type IV sensitivity, to reduce the Co addition for steel cost reduction, and finely tune heat treatment technologies to get mechanical properties able to perfectly fulfil TUV/EN.

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Muchas gracias por su atención

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PLATEA

PLATAFORMA TECNOLÓGICA ESPAÑOLA DEL ACERO

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