

# Tribology

research lines



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The Instituto de Tecnología Cerámica (ITC) is a concerted mixed Institute, established by agreement between the Ceramic Industry Research Association (AICE) and Universitat Jaume I of Castellón, which originated in 1969 in response to the needs of companies from the Spanish ceramic cluster. During its more than 40-year history, ITC has articulated a successful university–business cooperation system that has borne its fruits, witness the significant development of the Spanish ceramic tile manufacturing industry.

**ITC is committed** to providing solid support for Spanish ceramic companies in the defence and enhancement of their strategic positioning in the current global context, principally through innovation-enabling research and development actions, but also through whatever activities might serve to foster the competitiveness and growth of the sector, always based on sustainability criteria and commitment to societal well-being.

**ITC's mission** is focused on spearheading technology innovation and design processes in the Spanish ceramic sector, anticipating market and consumer needs regarding the uses and applications of ceramic materials, through professionalised management of a qualified human team committed to excellence in the sector.

The competence attained through ITC's wide-ranging research activity enables ITC today to extend its field of action to other types of processes and materials. Particularly noteworthy have been ITC's actions in the field of energy efficiency and the minimisation of industry's environmental impact, as well as in the functionalisation of ceramic surfaces and the achievement of new technical performance and aesthetic features of products related to the habitat hyper-sector and to other industries, such as the high-tech tool, advanced ceramics, automotive, petrochemical sectors, etc.

# application of tribology to the study of surface performance

ITC has been investigating ceramic surface properties for many years, pursuing various lines of actions and performing numerous research projects in the field of tribology, a science that studies **wear, friction, and lubrication phenomena**. In this line of research, ITC has studied the multiple aspects that affect tribological performance.

OVER 1000 R&D PROJECTS DEVELOPED THROUGHOUT THE HISTORY OF ITC, AMOUNTING TO ALMOST 40 MILLION EUROS.

In this research field, ITC studies have addressed the following:

**Mechanisms giving rise to surface wear in materials**, particularly in ceramics. In this line of work, methods simulating wear in traditional ceramic products (floor tiles, porcelain tableware, etc.) have been fine-tuned, and the influence of microstructure and surface mechanical properties on surface tribological behaviour has been studied.

**Mechanisms leading to ceramic surface scratching**, establishing methods of determining scratch resistance, which allow scratch resistance to be quantified and related to other surface characteristics.

**Roughness measurement techniques** in the field of traditional ceramics, which have enabled wear to be evaluated as volume loss, and roughness to be related to aesthetic properties.

**Indentation techniques** that can be adopted for the determination of the mechanical properties of ceramic surfaces, studying appropriate conditions for the performance of these determinations. ITC has thus also participated in project PL-95-2122: 'Measurement of surface hardness of ceramic tiles by Vickers indentation method', funded by the European Commission, aimed at establishing a method of determining the Vickers micro-hardness of ceramic tile surfaces.

**Implementation of nano-indentation-based** techniques that allow the elastic-plastic behaviour of thin coatings subject to scratching, wear, and impact resistance to be studied. In the course of this work, ITC has collaborated in a project funded by IMPIVA, entitled: 'Development of advanced hybrid materials for building construction, with optimised tribological properties', a project aimed at optimising organic-inorganic hybrid coating performance through mechanical and tribological characterisation of the coatings.

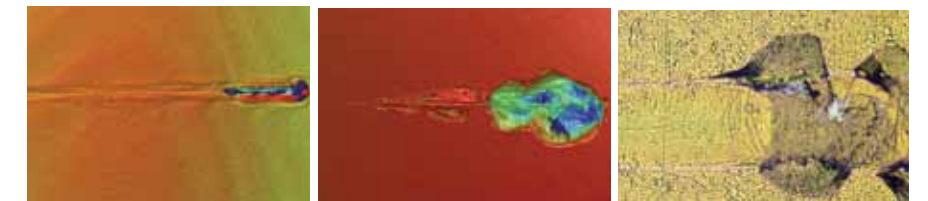
# european network for industrial wear prevention

The Instituto de Tecnología Cerámica is an active member of the recently created **European Network on Tribology ENIWEP**, whose principal aim is that of pooling European capabilities in the field of tribology, thus establishing a powerful, integrated instrument for enhancing the interaction between industry and tribology research, facilitating the transfer of technology and research results to industry and, in particular, to SMEs for rapid exploitation.

ITC IS A **REFERENCE PARTNER** IN DIFFERENT NATIONAL AND INTERNATIONAL NETWORKS AND TECHNOLOGY PLATFORMS.

ENIWEP, made up of 24 organisations from 17 European countries, will assure efficient transfer of tribotechnology to the European economic fabric by generating European projects, notably the Eureka projects ([www.eniwep.org](http://www.eniwep.org)). ENIWEP contributes to creating and developing:

- › A European network of Centres of Competence.
- › Close relations between research institutions and industry.
- › Possibilities for partner searches.
- › Technology and knowledge transfer.
- › Access to advanced technologies.
- › Access to new regions and markets.
- › Use of first-class equipment.
- › Efficient use of existing resources.
- › A European dimension by offering services to companies throughout Europe.

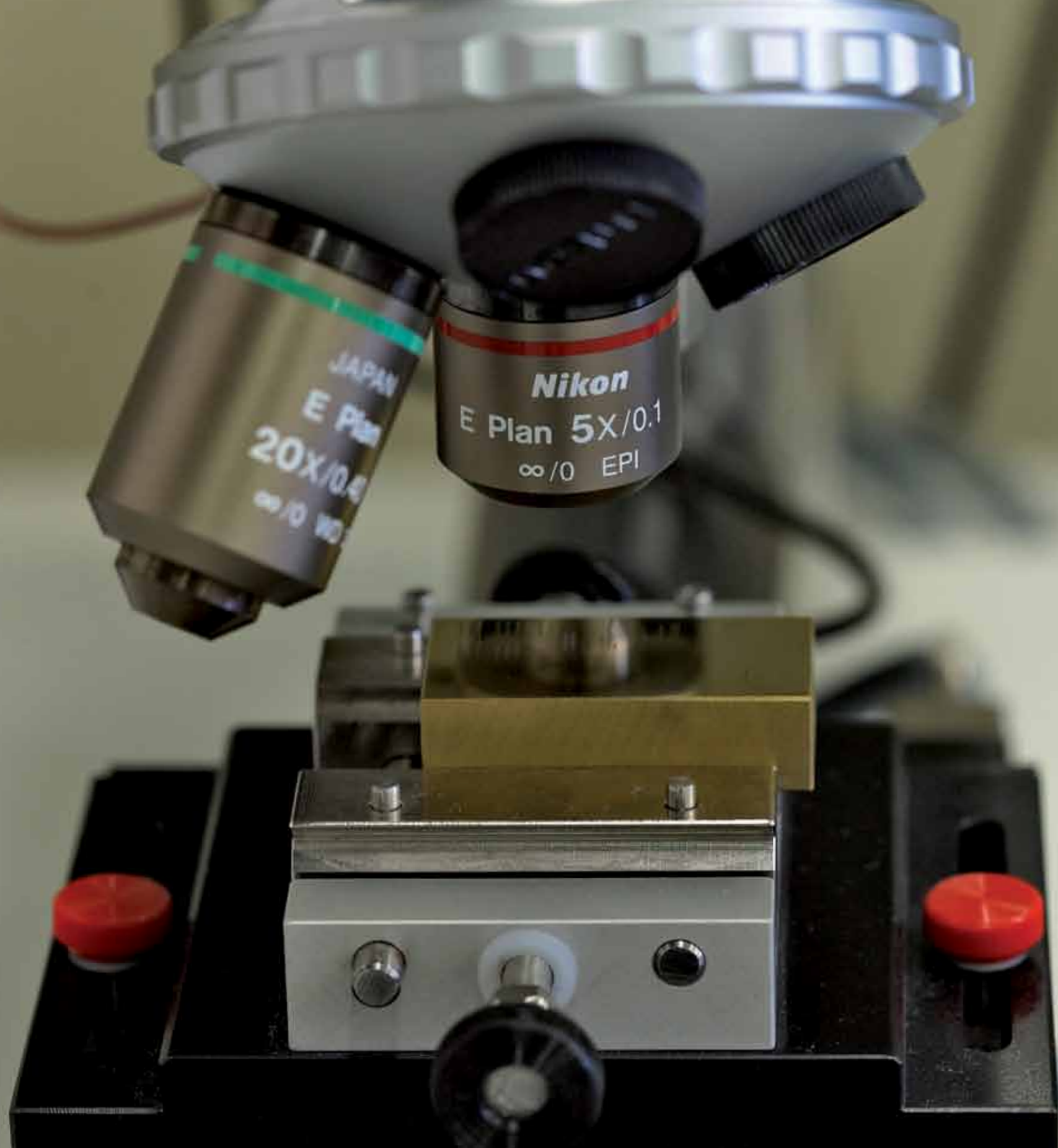


# tribostand

In this line of action, framed under the ENIWEP umbrella, ITC has coordinated the project TRIBOSTAND (<https://extranet.itc.uji.es/tribostand/default.aspx>), funded by the Spanish Ministry of Industry, Tourism and Trade (FIT-030000-2006-121) in a first stage, subsequently supported by the European Regional Development fund (ERDF) and by IMPIVA (Autonomous Government of Valencia) (IMIDIE/2009/4). The project focuses mainly on standardising the tribological tests shared by all the participating Centres and on launching an external service of tribological analyses and testing for the different sectors involved in the project (ceramics, metallurgy, etc.).

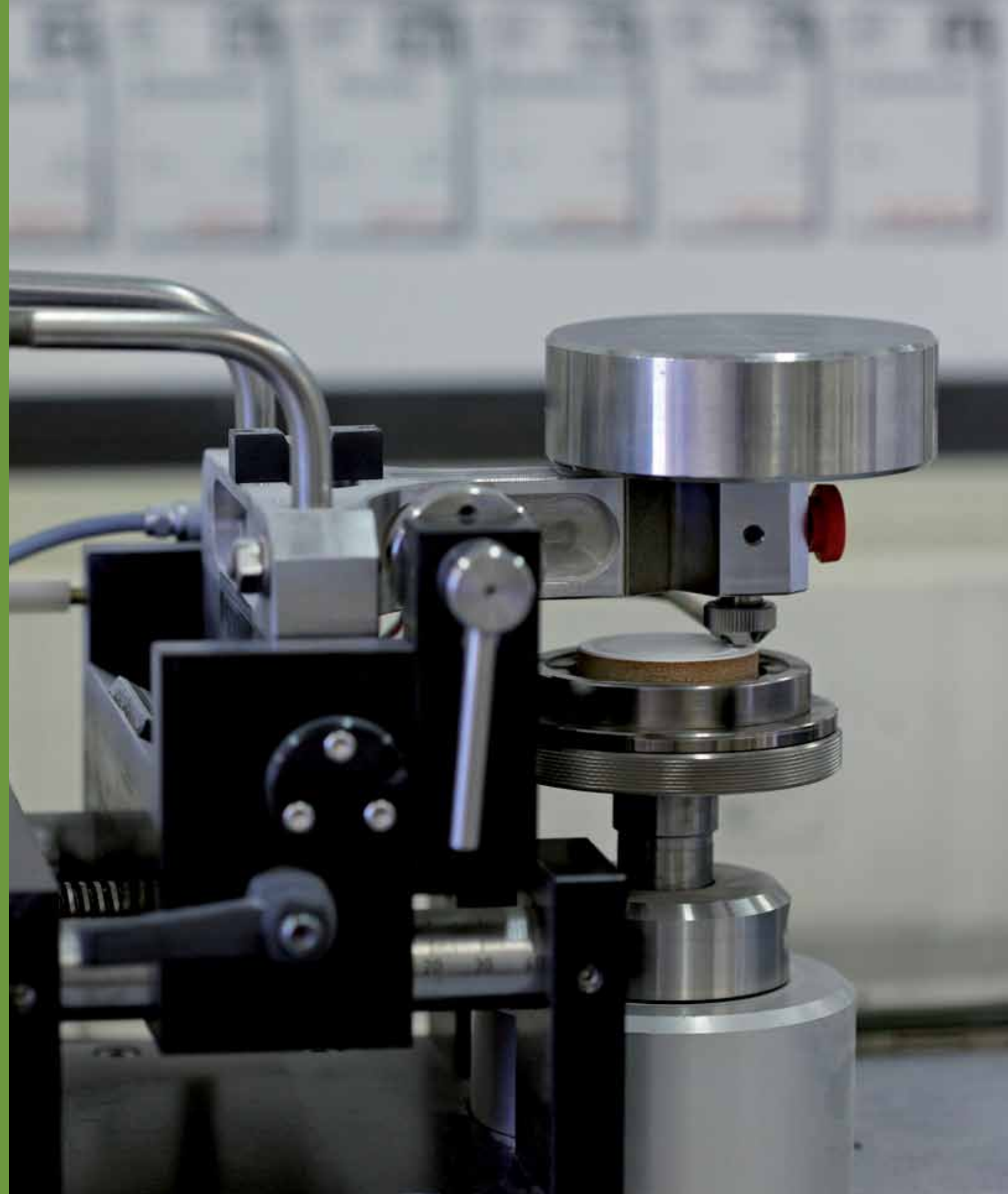


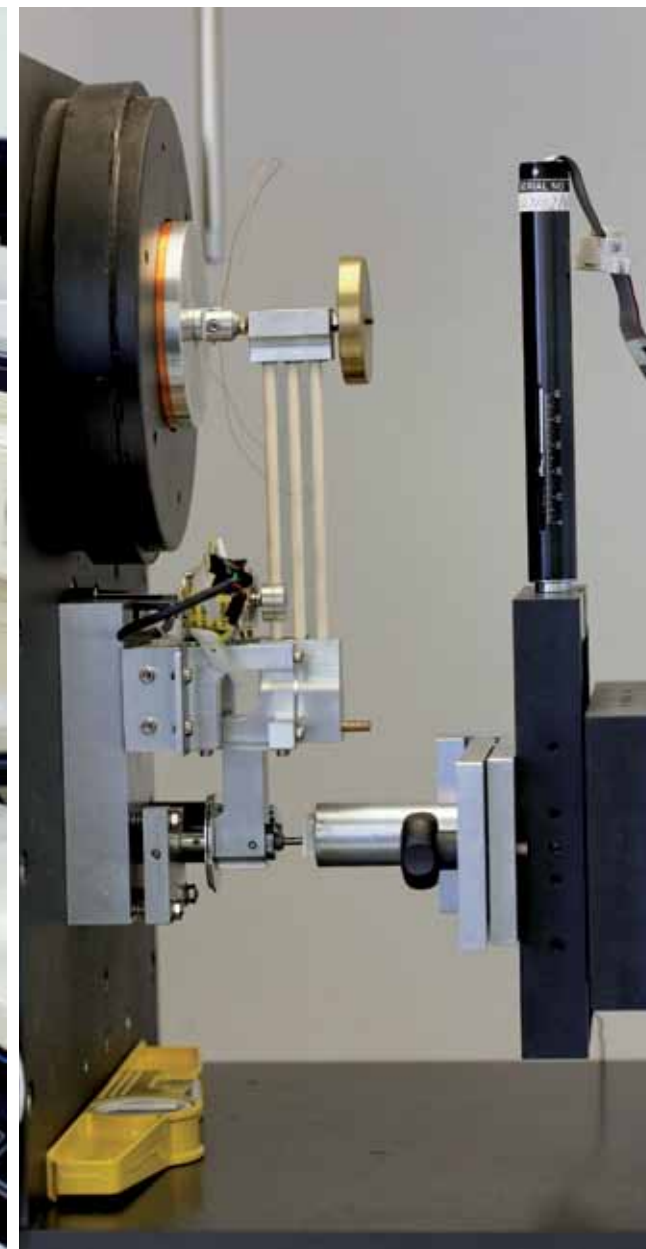
IN THE COURSE OF ITS 40-YEAR HISTORY, ITC HAS CARRIED OUT ABOUT **150,000 ANALYSES AND TESTS** OF THE MORE THAN **475 DIFFERENT TYPES** THAT IT CURRENTLY OFFERS.



# available equipment

ITC sets at the disposal of companies a great technological infrastructure of technical competence endorsed by both ITC's high number of external accreditations and its highly qualified human and instrumental resources, which assure total reliability with regard to the results obtained in the characterisation of raw materials and end products, and in the determination of their behaviour during the production process.





ITC CURRENTLY HAS  
TECHNICAL AND SCIENTIFIC EQUIPMENT  
FOR CONDUCTING R&D VALUED AT  
OVER 9 MILLION EUROS.

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- › XPS/ESCA (nanometre-scale chemical analyses of the surface).
  - › Microhardness testers.
  - › Nano-indenter (microhardness, scratching, wear, impact, pin-on-disk).
  - › Scratch tester.
  - › Macro and micro-tribometers (pin-on-disk and Calotest).
  - › Abrasion testers (Gabrielli, Taber).
  - › Optical profiler (white light interferometry, VSI).
  - › Roughness meter (mechanical and laser pick-ups).
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# technical references

ITC has the capability to transfer the knowledge acquired through the ongoing training of its team of qualified human resources, who keep their knowledge up to date by conducting various R&D&I actions and studies, in addition to participating in numerous science and technology forums worldwide and in different international platforms and consortia. This knowledge, together with that acquired or assimilated from other production sectors, serves to generate the innovation that is transmitted to the companies, which need this to maintain or to enhance their competitiveness.

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## R&D&I projects co-financed with public funding

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### European Commission

ENIWEPE – European Network for Industrial Wear Prevention. EUREKA, (2005-2009).

KMM-NoE 502243-2 - Knowledge-based Multicomponent Materials for Durable and Safe Performance, (2004-2007).

Polishcoverings - Development of an efficient and environmentally friendly polishing process for floor and wall coverings, (2002-2004).

Measurement of surface hardness of ceramic tiles by Vickers indentation method, (1995-1999).

### Central Administration

PID-560520-2009-6 – FLOORSHOE. Integral study of the friction mechanisms relating to different conditions of pedestrian traffic (2009-2011).

CIT-420000-2008-2 – Obtaining air plasma spray coatings with reconstituted nanostructured powders (2008-2010).

MAT2007-65335 – TRIBO-HOI-PN. Study of relationships between the tribological performance and the nanostructure of organic-inorganic hybrid materials with radical polymerisation (2007-2009).

FIT-030000-2006-121 – TRIBOSTAND. Standardisation of tribological tests (2006-2008).

MAT-2006-12945-C03-01 – RECAP. Development and properties of high-performance nanostructured coatings (2006-2009).

Development of a universal method for the accelerated evaluation of durability (2000-2003).

### Regional Administration

IMIDIE-2009-4- TRIBOSTAND. Standardisation of tribological tests (2009).

IMCOCA-2006-28 – Development of advanced hybrid materials for building construction with optimised tribological properties (2006-2007).

IMCOIB-2006-9 – Development of hybrid nanocomposite coatings and advanced polymers (2006).

Abrasion resistance of ceramic flooring in heavily trafficked public domains (2002- 2004).

Use of plasma spraying in the development of new applications on ceramic materials (2003).

Study of the influence of glaze characteristics on glazed tile impact resistance (2002).

Study of the influence of manufacturing parameters on glazed tile impact resistance (2001).

Development of a quantitative method of evaluating ceramic tile impact resistance (2000).

Relationship between ceramic glazes and the stress that they are subjected to (1999-2000).

Study of the methods of evaluating the slip resistance of surfaces exposed to pedestrian traffic (1999-2000).

THE DISSEMINATION OF THE RESULTS OF THE STUDIES CONDUCTED BY ITC FROM THE OUTSET HAS LED TO 600 PUBLICATIONS OF SCIENTIFIC ARTICLES IN SPECIALISED JOURNALS, 700 COMMUNICATIONS AT NATIONAL AND INTERNATIONAL CONFERENCES, AS WELL AS THE DEVELOPMENT OF 31 PATENTS.

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### Publications

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IBÁÑEZ, M.J.; GILABERT, J.; VICENT, M.; GÓMEZ, P.; MUÑOZ, D. Determination of the wear resistance of traditional ceramic materials by the micro-abrasion technique. *Wear*, 267(11), 2048-2054, 2009.

SALVADOR, M.D.; AMIGÓ, V.; SEGOVIA, F.; CANDEL, J.; BONACHE, V.; SÁNCHEZ, E.; CANTAVELLA, V. Comportamiento al desgaste de recubrimientos de WC proyectados por plasma a partir de polvos micro y nanoestructurados. *Rev. Metal. Madrid*, 44(3), 222-232, 2008.

SILVA, G.; MUÑOZ, A.; FELÍU, C.; MONZÓ, M.; BARBERA, J.; SOLER, C. Propuesta de un método normalizado para la determinación de la durabilidad frente al tránsito peatonal de pavimentos. *Ceram. Infor.*, 349, 77-88, 2008.

HUTCHINGS, I.M.; XU, Y.; SÁNCHEZ, E.; IBÁÑEZ, M.J.; QUEREDA, M.F. Optimisation of the polishing process for porcelain ceramic tiles. *Int. Ceram. J.*, Oct. 2006, 103-107, 2006.

CANTAVELLA, V.; SÁNCHEZ, E.; GARCÍA-TEN, J.; IBÁÑEZ, M.J.; SÁNCHEZ, J.; SOLER, C.; SALES, J.; MULET, F.; MOR, S. Modelización de la operación industrial de pulido de baldosas cerámicas. *Tec. Ceram.*, 343, 562-571, 2006.

SÁNCHEZ, E.; IBÁÑEZ, M.J.; GARCÍA-TEN, J.; QUEREDA, M.F.; XU, Y.M.; HUTCHINGS, I.M. Porcelain tile microstructure: Implications for polished tile properties. *J. Eur. Ceram. Soc.*, 26(13), 2533-2540, 2006.

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HUTCHINGS, I.M.; ADACHI, K.; XU, Y.; SÁNCHEZ, E.; IBÁÑEZ, M.J.; QUEREDA, M.F. Analysis and laboratory simulation of an industrial polishing process for porcelain ceramic tiles. *J. Eur. Ceram. Soc.*, 25, 3151-3156, 2005.

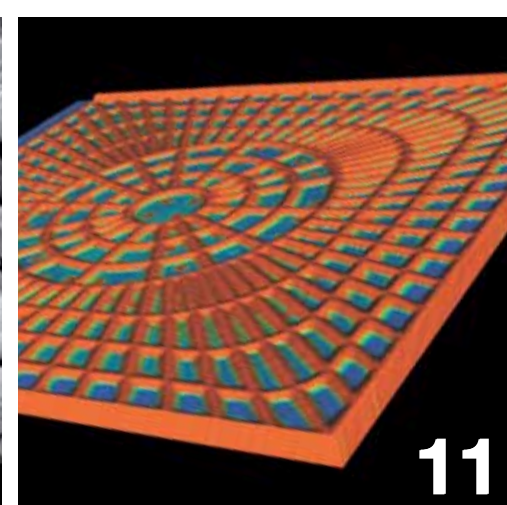
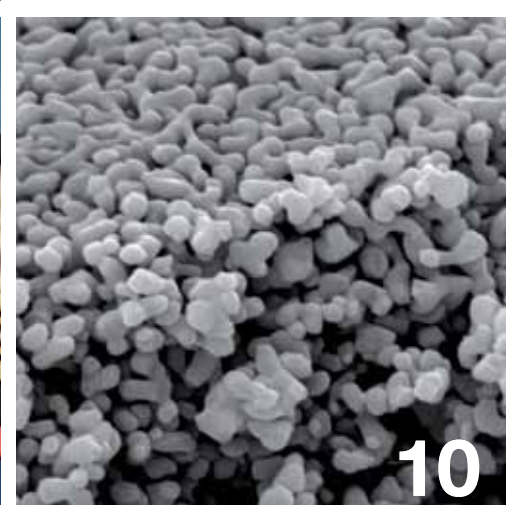
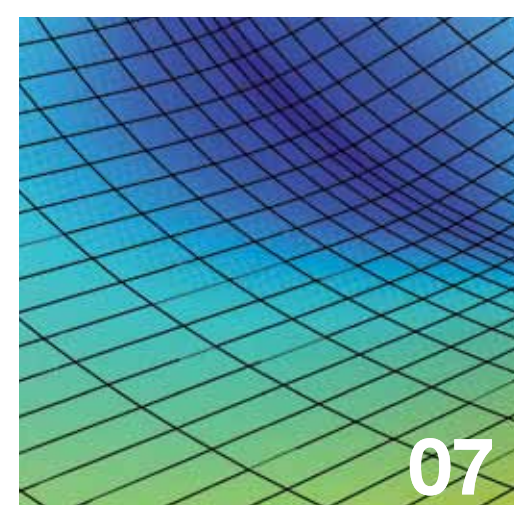
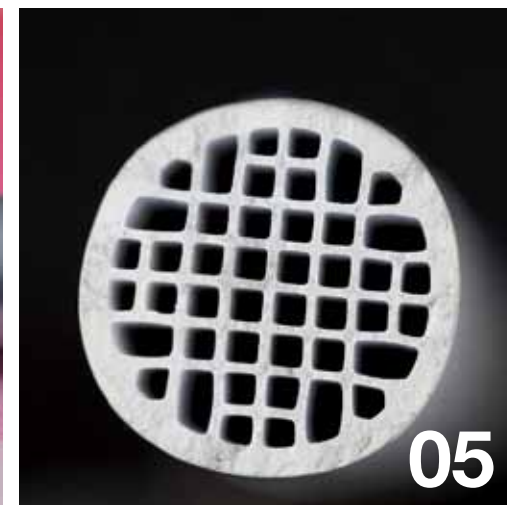
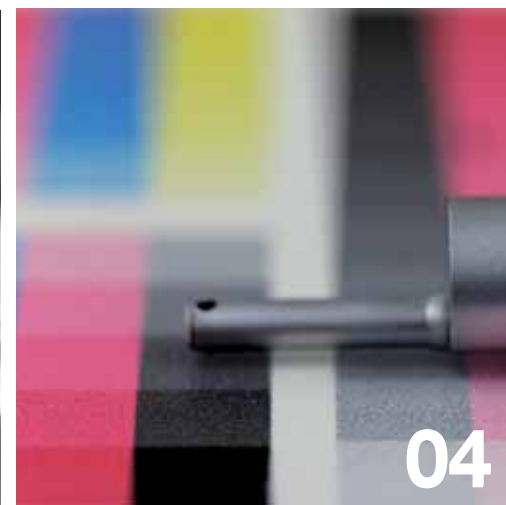
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  - 10 Nanotechnology
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8000m<sup>2</sup> SURFACE AREA DEVOTED  
TO RESEARCH AND DESIGN SPREAD  
OVER TWO HEADQUARTERS.



IMPIVA



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