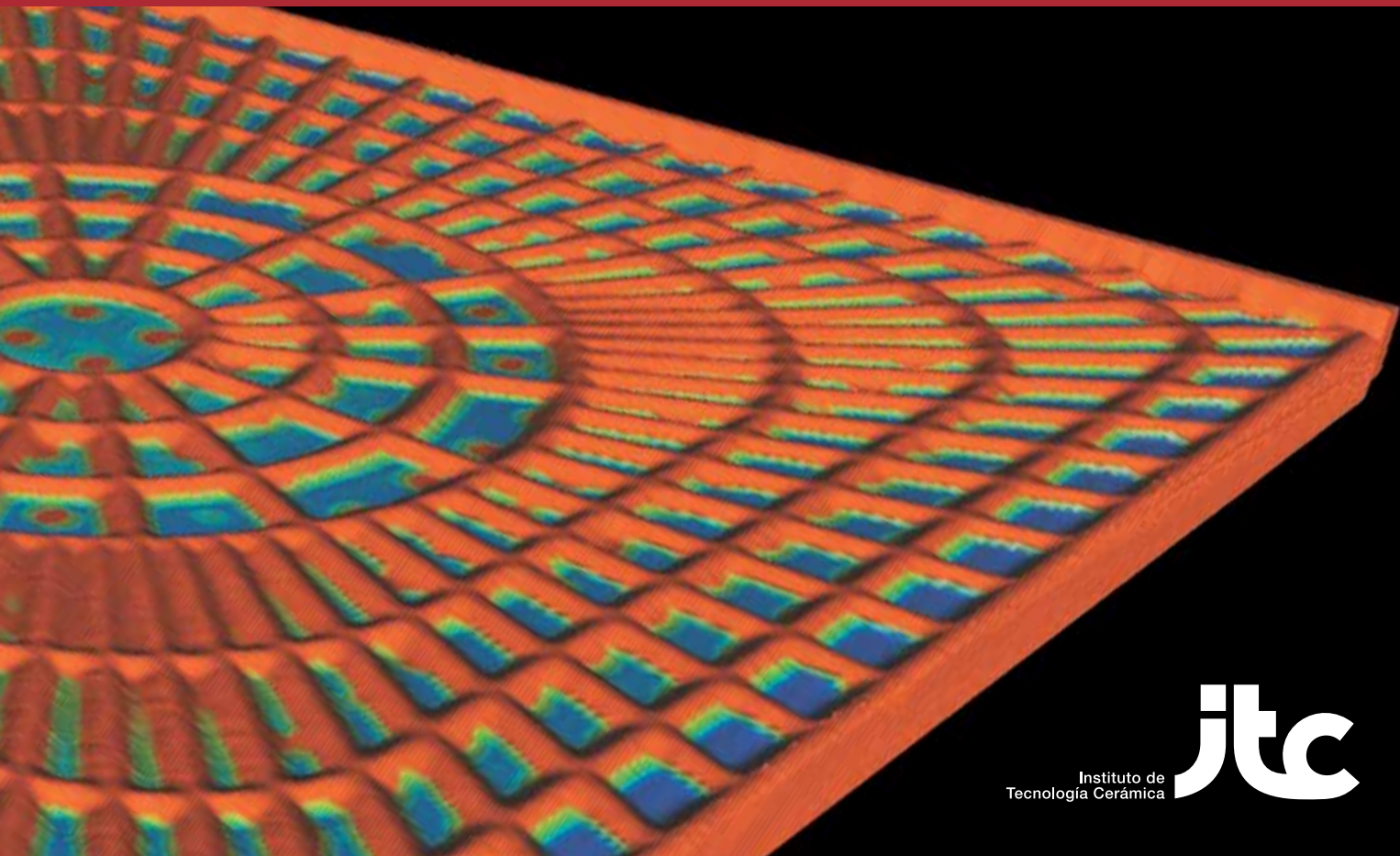


# Smart manufacturing

research lines



---

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.

# smart manufacturing

Smart manufacturing is fabrication that enables any product to be made at the smallest possible cost, the highest quality, and the lowest environmental impact. The Instituto de Tecnología Cerámica has the necessary capability, in human as well as in technical resources, to participate in the design and building of any machine or prototype that improves industrial manufacturing process stages.

The Area for Machines and Prototypes is the ITC strategic unit that focuses on performing R&D&I and technology consulting tasks relating to the following:

- › Design and construction of industrial machines and laboratory equipment.
- › Measurement of variables under industrial conditions, and automation of process stages.
- › Determination of powder flowability, and robotics applications to the ceramic process.
- › Technical consultancy and custom training.

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

## Design and construction of industrial machines and laboratory equipment

ITC provides companies with the possibility of designing and of constructing equipment and machinery, on both an industrial and laboratory level, tailored to company needs. Some examples follow of systems that have already been developed, which have been fully validated and proven in operation:

**Densexplorer®:** Measurement equipment that enables the thickness, mass, and bulk density distribution of ceramic materials to be determined by X-ray absorption.

**Silo design** by means of an own software aimed at avoiding powder segregations, stoppages during discharge, and fractures of the silo walls, optimising the silo as a function of the nature of the material held.

**Viscofree®:** Small device fitted in situ to the bell in order to maintain a consistent quantity of applied glaze.

**Kiln for firing automotive brakes:** Kiln for the final thermal treatment of automotive brakes, designed for continuous operation, thus raising plant productivity and reducing production costs.

**Solar dryer and kiln:** Prototypes for fritting, as well as for drying and firing tiles, using solar energy.

**Isoflux:** Bell that deposits the same quantity of glaze along its entire perimeter.

**Monomodule single-deck kiln:** pilot-scale kiln that reproduces the conditions of an industrial roller kiln.



Kiln for manufacturing brake linings.



OVER 1000 R&D PROJECTS DEVELOPED THROUGHOUT THE HISTORY OF ITC, AMOUNTING TO ALMOST 40 MILLION EUROS.  
DENSEXPLORER. Measurement of tile mass, thickness, and bulk density distribution.

---

## Measurement of variables under industrial conditions, and automation of process stages

---

The Area of Machines and Prototypes has the necessary technical resources to continuously measure industrial process variables, and to address the automation of the process stages in order to control all variables that affect production.

It is thus possible to measure:

**Kiln thermal cycles**, determining the real thermal cycle at different positions in a single-deck roller kiln.

**Transverse temperature gradients** in a single-deck roller kiln.

**Profiles in dryers** in order to determine gas humidity and temperature distribution inside vertical or horizontal dryers.

**Bulk density distribution** of ceramic tiles using pressure-sensitive devices and an own software: DENSIMED.

In addition, it is also possible automatically to control:

**The continuous mill** and, thus, to maintain constant density of the suspension exiting the mill.

**The spray dryer**, with a view to always maintaining the same spray-dried powder moisture content.

**The press**, in order continuously to assure a given pre-set tile bulk density.



VISCOFREE®. Optimised bell waterfall glaze application system.

---

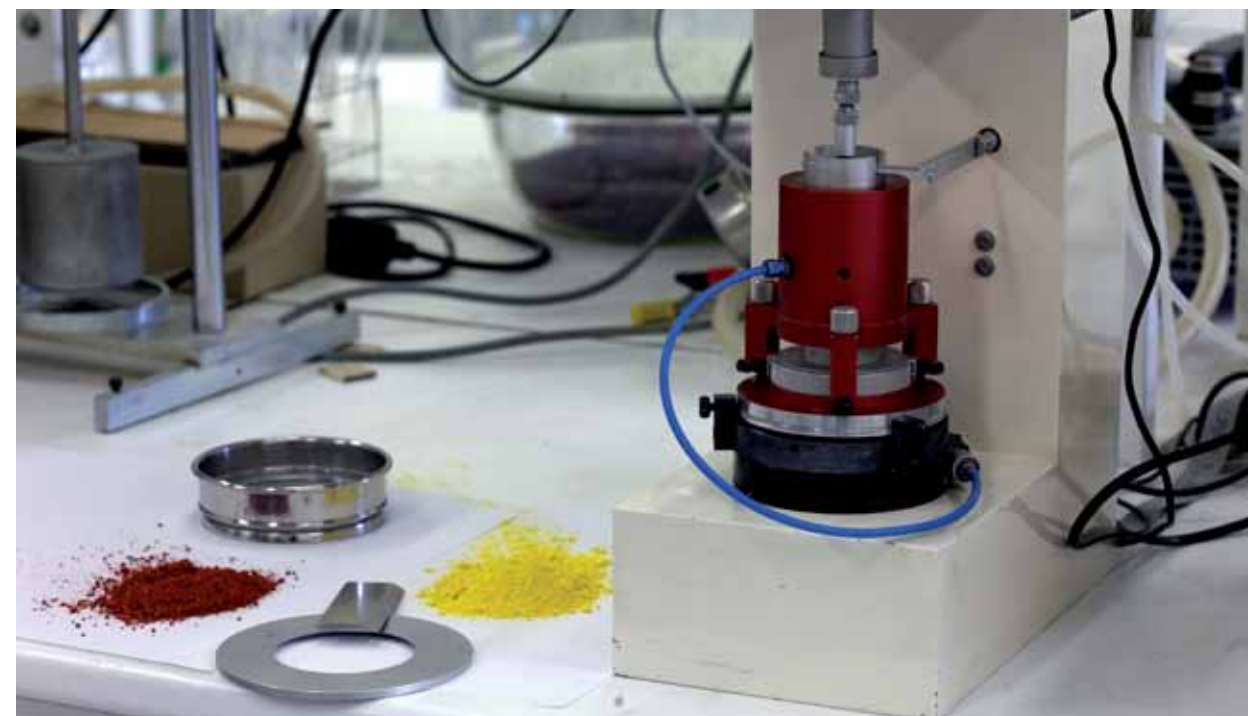
## Determination of powder flowability, and applications of robotics to the ceramic process

---

In order to establish the flowability of particulate materials, using different methods (flow meter, Hausner ratio, and shear cell), thus minimising the occurrence of problems during the handling of particulate materials in industry, such as interruptions in silo discharges, segregations, overpressures on silo walls, etc...

In this context, ITC most frequently performs the following activities:

- › Measurement of the cohesiveness of particulate materials.
- › Measurement of the powder flow function.
- › Influence of fluidisers on powder behaviour.



Measurement of powder flowability.

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

### Technical consulting and custom training

Detailed studies are sometimes required of work systems in production plants. The Instituto de Tecnología Cerámica has the capability to evaluate processes, to collaborate in improving these, as well as to train the relevant personnel and to update their knowledge, by means of:

Technical audits.

Implementation of manufacturing controls.

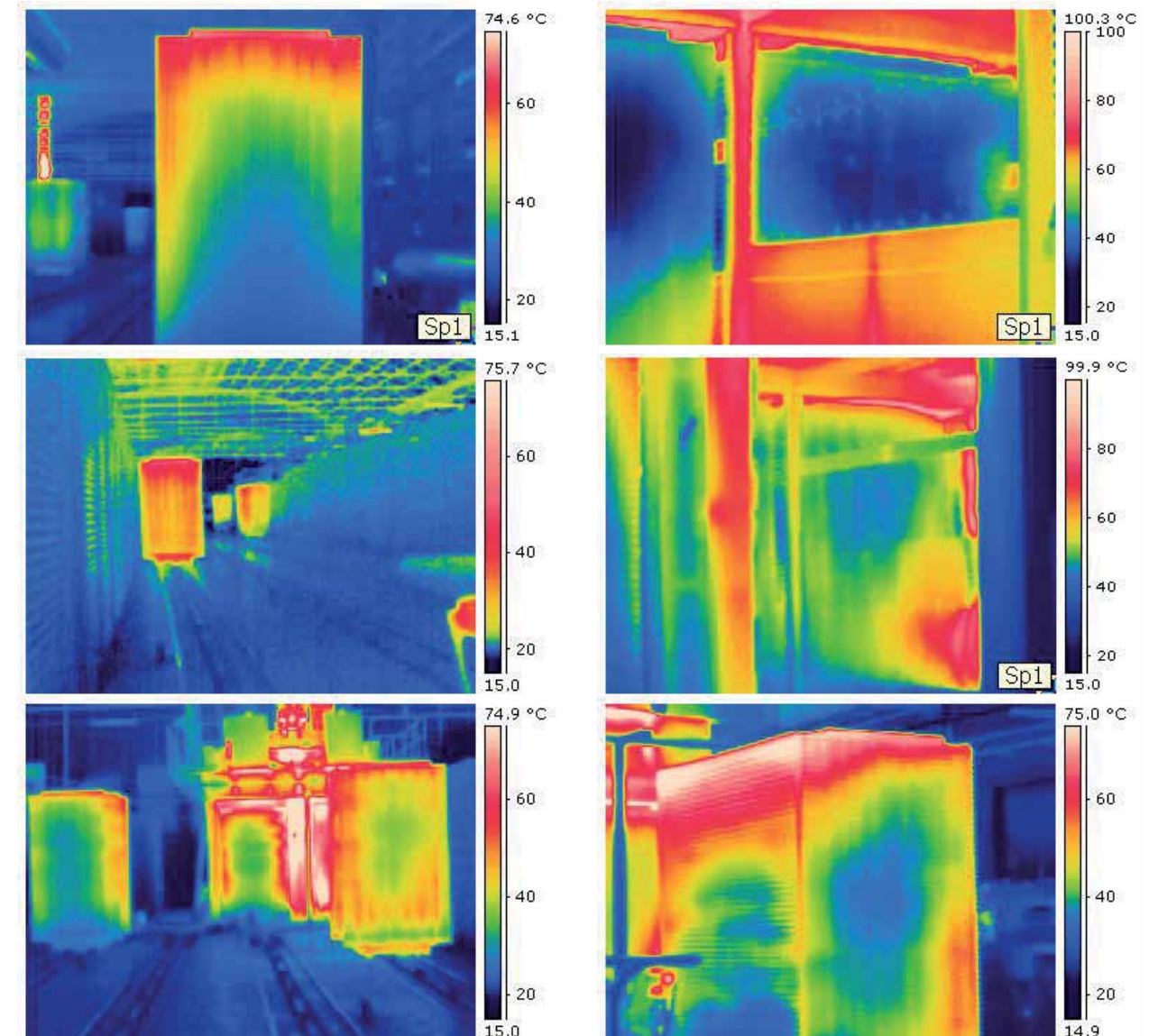
Monitoring of industrial processes.

Training courses: Automatic control of the pressing operation, powder characterisation, storage, and transport in industry.



Automatic control system of a hydraulic press.

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



Improvement of the operating conditions of a car dryer by thermal profile measurement.

# 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.

## Private companies for which work has been conducted

ALCALAGRÉS, S.A.  
ARCILLA BLANCA, S.A.  
ARENAS MINERALES, S.A.  
ATOMIZADORA, S.A.  
AZULEJERA TÉCNICA, S.A.  
AZULEJOS ALCOR 1, S.A.  
AZUVI, S.A.  
CERÁMICA MERIDIANO, S.A.  
CERÁMICA SALONI, S.A.  
CERÁMICAS DEL FOIX, S.A.  
CERÁMICAS DIAGO, S.A.  
ESTUDIO CERÁMICO, S.A.  
EXAGRES, S.A.

FERRAES CERÁMICAS, S.A.  
FERRO SPAIN, S.A.  
GESTIÓN DE RESIDUOS ESPECIALES DE CATALUÑA, S.A.  
GLAPILK, A.I.E  
GRES DE ARAGÓN CAÑADA, S.A.  
GAROGRES, S.A.  
HIJOS DE CIPRIANO CASTELLÓ ALFONSO, S.A.  
INDUSTRIAS ALCORENSE CONFEDERADAS, S.A.  
INDUSTRIAS MONZONÍS, S.L.  
KERABEN GRUPO, S.A.

KERAFRIT, S.A.  
PERONDA CERÁMICAS, S.A.  
PORCELANATTO, S.A.  
PORCELANOSA, S.A.  
PROYING XXI INGENIERÍA, S.L.U.  
ROIG CERÁMICA, S.A.,  
SEGORBE PORCELÁNICO, S.A.  
TALLERES JOIS, S.A.  
TAULELL, S.A.  
TMD FRICTION ESPAÑA, S.L.  
URALITA IBERIA, S.L.  
VENÍS, S.A.  
ZIRCONIO, S.A.

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

Valencia Regional Department of Industry, Commerce, and Innovation. Strategic industrial diversification actions for the Valencia Region 2009.

R&D Programme for Technology Institutes of the IMPIVA Network 2006-2009. Study of the ceramic powder pressing operation under industrial conditions with a view to, continuously and automatically, maintaining constant bulk density of the formed tiles.

ENE2006-13267-C05-02. SOLCER II - Design and construction of equipment for pilot-scale processing of ceramic materials using solar energy. Ministry of Education and Science. 2006-2008.

IMPIVA. Competitiveness Plan for the Valencian company 2006-2007. Development of machines, prototypes,

and control systems for improving the ceramic product manufacturing process.

REN2003-09247-C04-04. SOLCER I - Application of solar energy in processing ceramic materials. Ministry of Science and Technology. 2003-2006.

MINISTRY OF SCIENCE AND TECHNOLOGY. National Plan for Scientific Research, Development, and Technology Transfer 2000-2003. Construction of an industrial instrument for the non-destructive measurement of the bulk density and integrity of large-sized ceramic pieces at an optimised speed.

IMPYGD/2003/24, IMPIVA, Plan for SME Consolidation and Competitiveness. Rheological database of particulate ceramic materials.

IMPIVA, IMPIVA, Plan for SME Consolidation and Competitiveness. Computer-aided silo design.

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.

---

### Publications

---

MALLOL, G.; BOIX, J.; LLORENS, D.; BAUTISTA, Y.; RODRIGO, M.D.; FONT, F. Development of a glazing system insensitive to variations in glaze viscosity. *Interceram*, 57(3), 156-163, 2008.

MALLOL, G. Controllo e automazione nell'industria ceramica. Evoluzione e prospettive. *Ceram. Inf.*, 458, 123-136, 2007.

MALLOL, G.; LLORENS, D.; FELÍU, C.; CASTRO, F. Medida en continuo de la humedad de los soportes cerámicos prensados. *Ceram. Inf.*, 289, 81-90, 2002.

CANTAVELLA, V.; SÁNCHEZ, E.; MALLOL, G.; MONFORT, E.; MIRALLES, L.; CUESTA, E.; GARCÍA, M.C. Control of the continuous milling operation. *Ceram. Acta*, 14(3-4), 12-28, 2002.

AMORÓS, J.L.; MALLOL, G.; SÁNCHEZ, E.; GARCÍA, J. Conception des silos et tremies de stockage des materiaux pulvérulents et operations de soutirage. *Ind. Ceram. Verrière*, 958, 196-204, 2000.

FERRER, C.; LLORENS, D.; MALLOL, G.; MONFORT, E.; MORENO, A. Optimización de las condiciones de funcionamiento en hornos monoestrato (III). Medida de gradientes transversales de temperatura. *Tec. Ceram.*, 227, 653-662, 1994.

NEGRE, F.; JARQUE, J.C.; MALLOL, G.; SÁEZ, M. Determinación en continuo y en tiempo real de la humedad del polvo cerámico secado por atomización. *Tec. Ceram.*, 200, 34-42, 1992.

---

### Related patents

---

AICE, ASOCIACIÓN DE INVESTIGACIÓN DE LAS INDUSTRIAS CERÁMICAS. Procedure and equipment for determining temperature distribution in thermal machines with roller systems for product transport. ES2102943, 1998-03-16.

AICE, ASOCIACIÓN DE INVESTIGACIÓN DE LAS INDUSTRIAS CERÁMICAS; ATOMIZADORA, S.A. Control system of ceramic suspension density. ES2294881, 2009-02-16.

AICE, ASOCIACIÓN DE INVESTIGACIÓN DE LAS INDUSTRIAS CERÁMICAS. Method and apparatus for non-destructive density measurement. ES2247933, 2007-05-16.

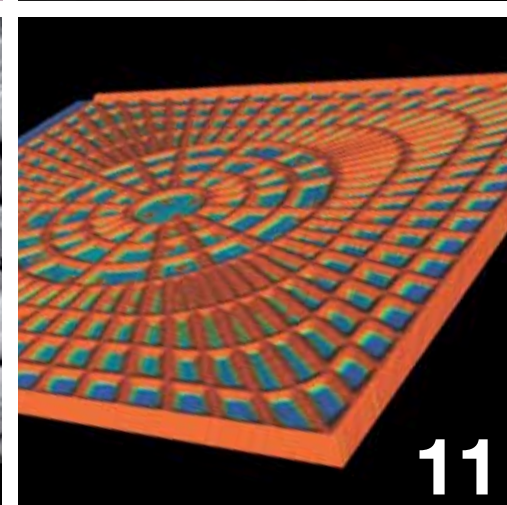
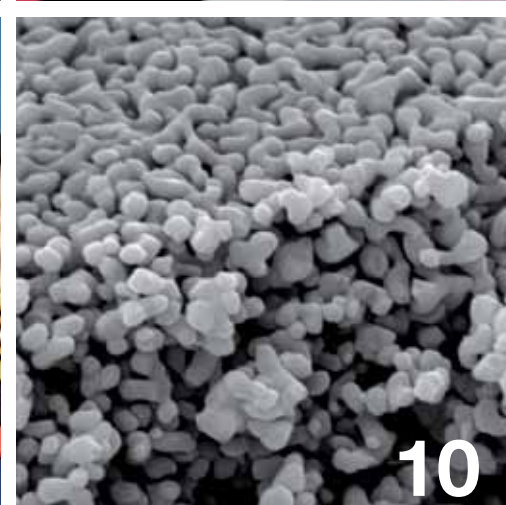
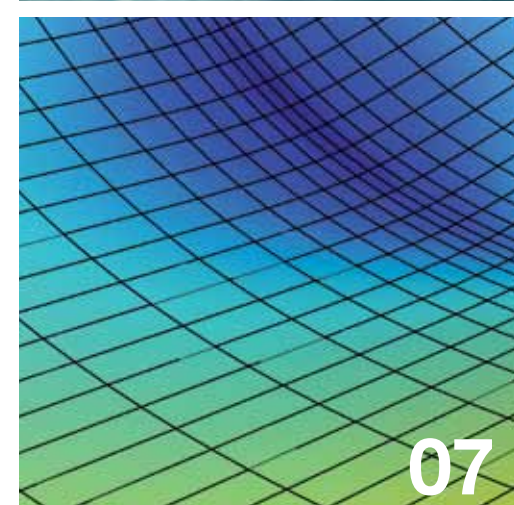
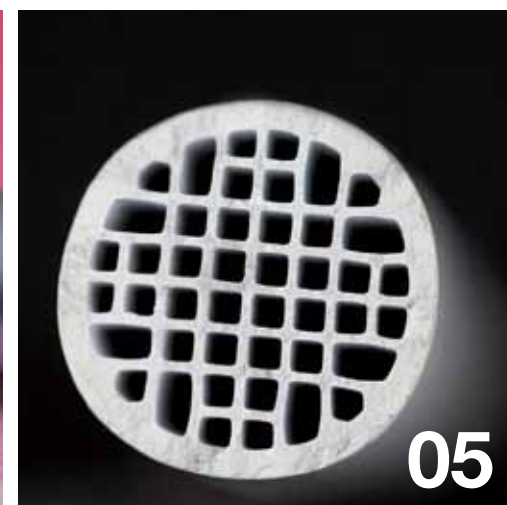
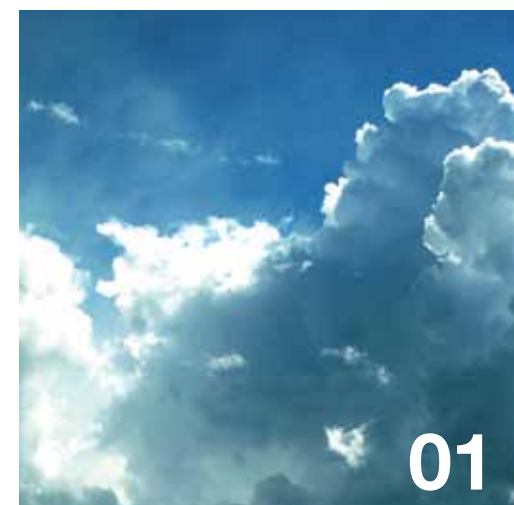
AICE, ASOCIACIÓN DE INVESTIGACIÓN DE LAS INDUSTRIAS CERÁMI-

CAS. Method and device for automatic control of ceramic tile bulk density. ES2249993, 2007-05-16.

AICE, ASOCIACIÓN DE INVESTIGACIÓN DE LAS INDUSTRIAS CERÁMICAS. Device for feeding liquids or suspensions. ES2323626, 2009-07-21.



- 
- 01 Environmental technologies
  - 02 Occupational safety and health
  - 03 Tribology
  - 04 New coatings and surface treatments
  - 05 Advanced ceramics
  - 06 Construction systems and energy-efficiency for architecture
  - 07 Simulation of processes and materials
  - 08 Design
  - 09 Energy saving and energy efficiency
  - 10 Nanotechnology
  - 11 Smart manufacturing
- 



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



"All rights reserved. The content of this document enjoys the protection afforded by law and may not be communicated, transformed, reproduced, or publicly distributed, either wholly or in part, without the express authorisation of Instituto de Tecnología Cerámica-AICE ITC, 2010. © ITC-AICE, 2010.

---

Sede Central  
Campus Universitario Riu Sec  
Av. Vicent Sos Baynat s/n  
12006 Castellón (Spain)

---

Sede Alicer  
Av. del Mar 42  
12003 Castellón (Spain)

---

[www.itc.uji.es](http://www.itc.uji.es)  
[info@itc.uji.es](mailto:info@itc.uji.es)  
T. +34 964 34 24 24  
F. +34 964 34 24 25

