LIFECERAM. Zero waste in ceramic tile manufacture.

Paqui Quereda Vázquez
Head of the Laboratory for Ceramic Compositions
Area of Materials and Ceramic Tecnologies

LIFE12 ENV/ES/230-LIFE CERAM
is co-funded by the European Commission
LIFE+ Environment Policy and Governance programme.
Title of the project: LIFE CERAM. Zero Waste in Ceramic Tile Manufacture

Funding programme: LIFE +

Call: 2012

Budget: 799,502 €  50 % UE Co-funding

Length: Start 01/09/2013 End 30/06/2016

Website of the project: http://www.lifeceram.eu
Consortium:

Co-ordinator:

AICE-ITC. *R&D centre*.

Partners and roles:

Asociación Española de fabricantes de azulejos y Pavimentos Cerámicos (ASCER). *Manufacturers association*.

Chumillas & Tarongi. *Machinery manufacturer*.

Keros Cerámica. *Tile manufacturer*.

Vernis. *Frit and glaze manufacturer*. 
DESCRIPTION OF THE PROJECT

Background:
The manufacturing of ceramic tiles generates wastes at different stages of the production process (1.4 million ton/year).
DESCRIPTION OF THE PROJECT

Background:

Green scrap 45%
Fired scrap 41%
Polishing sludge 8%
Glaze sludge 4%
Frit residues 2%
Dust from kiln filters 0.2%
Polishing sludge 8%
Glaze sludge 4%
Frit residues 2%
Dust from kiln filters 0.2%
Green scrap 45%
Fired scrap 41%
DESCRIPTION OF THE PROJECT

Objectives:

➢ To achieve zero-waste in the manufacture of ceramic tiles. The strategy consists of:

✓ Developing a new ceramic tile, consisting mainly of waste, for outdoor applications.

✓ Designing a sustainable process based on dry milling and granulation technologies.
### ACTION B1. CHARACTERIZATION OF WASTES

<table>
<thead>
<tr>
<th></th>
<th>Green scrap</th>
<th>Fired scrap</th>
<th>Glaze sludge</th>
<th>Dust from kiln filters</th>
<th>Polishing sludge</th>
<th>Frit residues</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>63,3</td>
<td>67,2</td>
<td>58,0</td>
<td>1,00</td>
<td>60,9</td>
<td>60,6</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>16,9</td>
<td>17,9</td>
<td>12,3</td>
<td>0,31</td>
<td>15,2</td>
<td>4,7</td>
</tr>
<tr>
<td>B₂O₃</td>
<td>0,1</td>
<td>0,1</td>
<td>2,6</td>
<td>0,22</td>
<td>0,93</td>
<td>8,0</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>3,8</td>
<td>4,1</td>
<td>0,40</td>
<td>&lt;0,15</td>
<td>0,84</td>
<td>0,1</td>
</tr>
<tr>
<td>CaO</td>
<td>3,0</td>
<td>3,3</td>
<td>9,7</td>
<td>62</td>
<td>3,81</td>
<td>12,0</td>
</tr>
<tr>
<td>MgO</td>
<td>1,2</td>
<td>1,2</td>
<td>1,66</td>
<td>0,44</td>
<td>3,57</td>
<td>2,9</td>
</tr>
<tr>
<td>Na₂O</td>
<td>1,8</td>
<td>1,9</td>
<td>1,98</td>
<td>0,25</td>
<td>3,33</td>
<td>2,0</td>
</tr>
<tr>
<td>K₂O</td>
<td>2,8</td>
<td>3,0</td>
<td>2,69</td>
<td>0,46</td>
<td>2,48</td>
<td>3,4</td>
</tr>
<tr>
<td>TiO₂</td>
<td>0,7</td>
<td>0,7</td>
<td>0,16</td>
<td>0,01</td>
<td>0,46</td>
<td>0,1</td>
</tr>
<tr>
<td>ZrO₂</td>
<td>0,2</td>
<td>0,2</td>
<td>2,47</td>
<td>0,01</td>
<td>0,46</td>
<td>2,9</td>
</tr>
<tr>
<td>ZnO</td>
<td>0,2</td>
<td>0,3</td>
<td>4,09</td>
<td>0,12</td>
<td>2,51</td>
<td>6,6</td>
</tr>
<tr>
<td>BaO</td>
<td>0,1</td>
<td>0,1</td>
<td>1,09</td>
<td>0,02</td>
<td>0,65</td>
<td>2,4</td>
</tr>
<tr>
<td>S</td>
<td>-</td>
<td>-</td>
<td>0,02</td>
<td>2,53</td>
<td>0,03</td>
<td>-</td>
</tr>
<tr>
<td>Cl</td>
<td>-</td>
<td>-</td>
<td>0,05</td>
<td>1,41</td>
<td>0,79</td>
<td>-</td>
</tr>
<tr>
<td>F</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>32,0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ppc</td>
<td>6,0</td>
<td>0,2</td>
<td>2,72</td>
<td>7,63</td>
<td>3,90</td>
<td>-</td>
</tr>
</tbody>
</table>
ACTION B2. BODY COMPOSITION PREPARATION PROCESS

DRY MILLING

HAMMER MILL

DISC MILL

PENDULUM MILL

GRANULATION

LOW INTENSITY

HIGH INTENSITY
ACTION B2. BODY COMPOSITION PREPARATION PROCESS

DRY MILLING

HAMMER MILL

DISC MILL

PENDULUM MILL

GRANULATION

LOW INTENSITY

HIGH INTENSITY
LIFECERAM

ACTION B3. BODY AND GLAZE COMPOSITIONS

![Graph showing linear shrinkage and water absorption against temperature]

- Linear shrinkage (%)
- Water absorption (%)

Temperature (ºC)

Legend:
- Lifeceram body
- Stoneware tile
- Porcelain tile
- L.S.
- W.A.
ACTION B4. INDUSTRIAL TRIALS
ACTION B5. TECHNICAL AND ENVIRONMENTAL ASSESSMENT

Technical assessment

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water absorption (%)</td>
<td>2.7</td>
</tr>
<tr>
<td>Bulk density (g/cm³)</td>
<td>2.32</td>
</tr>
<tr>
<td>Slip resistance. ENV 12633. USRV</td>
<td>54</td>
</tr>
<tr>
<td>Breaking load. EN ISO 10545-4 (N)</td>
<td>6060 (15 mm)</td>
</tr>
<tr>
<td>Modulus of rupture. EN ISO 10545-4 (N/mm²)</td>
<td>38</td>
</tr>
</tbody>
</table>

Environmental assessment

The urban tile can be classified as non-hazardous based on the results of the environmental characterisation tests:

- ✓ Leaching tests
- ✓ Determination of gas emissions
CONCLUSIONS

- In the LIFE CERAM project, the different wastes generated in the ceramic tile manufacturing process have been characterised.

- An urban floor tile has been developed, whose body is entirely made up of these wastes.

- A highly sustainable body preparation process has been designed, that allows all ceramic wastes to be recycled.

- The body composition displays appropriate behaviour in the different production process stages and exhibits the required properties for use as urban flooring.

- The product is respectful with the environment, despite being made up of wastes, as the acid compound emissions are similar to those of current body compositions and the ion concentrations in the leaching tests are lower than those required to classify a waste as inert.

- Industrial trials have been conducted to validate the results obtained in the laboratory and their results have been satisfactory.