03•13 JULY VOL. 62

Interceram
INTERNATIONAL CERAMIC REVIEW

SPECIAL EDITION 2013

REFRACTORIES

MANUAL I/2013

www.interceram-refractories.info

03
2013

Markets

The Brazilian Ceramic and Refractory Industry

Refractories Forum

Characterization and Performance of New Generation SiC-based Trough Castable

Review Papers

Preparation of Ca-α/β-Sialon Powders via Reaction Nitridation

Hydrotalcite: A Potentially Useful Raw Material for Refractories

Assessment of Egyptian Raw and Waste Materials for Refractory Ceramics

Special Technologies

Sintering and Thermal Shock Properties of Al_2O_3-Fe_2O_3 Composite

Preparation of β-Sialon/Ti(C, N) Composite Materials

Effect of Fe_2O_3 and MgO on Gelcasting and Sinterability of Alumina Ceramics

Synthesis and Characterization of Magnesium Aluminate Spinel by Co-Precipitation

Effects of Fluoride Additives on Synthesis of Porous Mullite Ceramic

Pressure Slip Casting: A Novel Process for Producing Alumina Bodies with Superior Green Density

Effects of Spinel on the Physical Properties of Refining Slag

MARKETS

U. Soares do Prado, J.C. Bressiani***

The Brazilian Ceramic and Refractory Industry in the Last Decade

THE AUTHORS

The corresponding author, **Ulisses Soares do Prado**, is a Materials Engineer and received his Ph.D. in Nuclear Technology from the Energetic and Nuclear Research Institute (IPEN), Brazil (2008). He has worked in the research department of the Brazilian metallurgic and ceramic industries and is currently Director of Lining Consulting and the Brazilian Ceramic Association (ABCeram). **E-Mail: ulissesprado@uol.com.br**

José Carlos Bressiani is a Materials Engineer and received his Ph.D. in materials from the Max-Planck Institute, Stuttgart University, Germany (1984). He has had a research position in nuclear technology at the Energetic and Nuclear Research Institute (IPEN) since 1975. He was twice president of the Brazilian Ceramics Association (1991/1992 and 1998/2000). Currently, he is Head of IPEN and Director of Brazilian Ceramic Association (ABCeram). He is the founder and co-editor of the Materials Research Journal. **E-Mail: jbressia@ipen.br**

ABSTRACT

In recent years, the Brazilian ceramic industry has grown. This paper reviews the development of ceramics in Brazil during the last decade and presents data from the corresponding industries: structures, tiles, refractories, frits, tableware, sanitary ware, glasses and Portland cement. The Brazilian ceramics market is described and new opportunities for the next decade are analyzed.

KEYWORDS

Brazil, ceramic industry, refractory industry, last decade

INTERCERAM 62 (2013 [3]

1 Introduction

The ceramic industry plays an important role in Brazil by earning foreign currency and by providing employment. In this report we hope to continue the review given by Bustamante and Bressiani [1] in 2000 and also discuss the development of ceramics in Brazil during the last decade (2001/2010). We have also included here the related productive sectors of glasses and Portland cement, as these are also ceramic materials. Normally, these items are excluded from reports of this nature because of their unique properties.

The data presented here was obtained from limited publications that have reported numbers in different sectors, the Brazilian Ministry of Mines and Energy's data sheets and also websites of associations as well as syndicates in the ceramic area.

Given that the ceramic industry has a very close link with civil construction, the expansion of the latter in the last decade determined the growth of the former. Structural ceramics, coatings, sanitary ware, glasses and Portland cement are directly related to civil construction. Sectors such as refractories and frits are at the base of the production chain, as these are used in the manufacture of civil construction materials. An increase in the average earnings of the workforce, ease in financing, government stimulus projects in civil construction and the infrastructure requiring projects led by mega events such as the Soccer World Cup (2014) and the Summer Olympics (2016), were determining factors in the overall growth of civil construction and consequently, the improved performance of the ceramics industry.

A decline in the indicators during the early years of this decade was followed by recovery. Even with the economic crisis of 2008, the ceramic industry registered growth in most sectors and this happened as shown below. On the other hand, with an increase in domestic consumption, Brazil turned out to be an attractive market for international ceramic companies, which had the advantage of a favourable exchange rate for imports during the last few years. In the ceramic industry, this fact is significant in the refractory sector, where companies from all over the world are trying to enter the Brazilian market. This aspect has been observed in the finishing materials and electrical ceramics industries. However, in the tableware sector, unfair competition from Chinese products has had a negative impact.

2 Structural ceramics

The main characteristic of this sector is that the industry is highly segmented and spread out over the whole country, with units relatively close to the consumer markets. Even though there are exceptions, most of the producing units are small companies with simple, family managed organizations. Nevertheless, it is an important basic activity for civil construction and it produces solid and air bricks, structural and sealing blocks, roof tiles, glazed clay pipes and rustic floor tiles. Besides this, it plays an important social role and as per data of ANICER (National Association of the Ceramic Industry) an estimated 7431 companies in the country have generated 293,000 jobs and with an annual turnover of US$ 9 billion as shown in Table 1 [2].

* Brazilian Ceramic Association (ABCeram)/Lining Consulting, São Paulo (Brazil)

** Brazilian Ceramic Association (ABCeram)/Nuclear and Energy Research Institute (IPEN–CNEN/SP), São Paulo (Brazil)

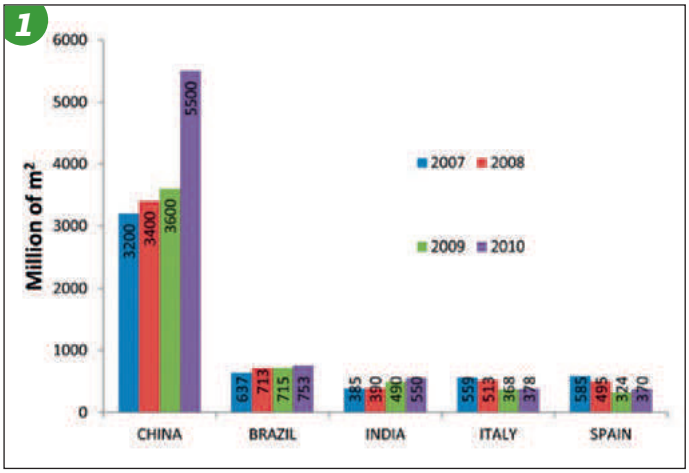

Fig. 1 • Largest producers of ceramic tiles in the world in the last few years [2]

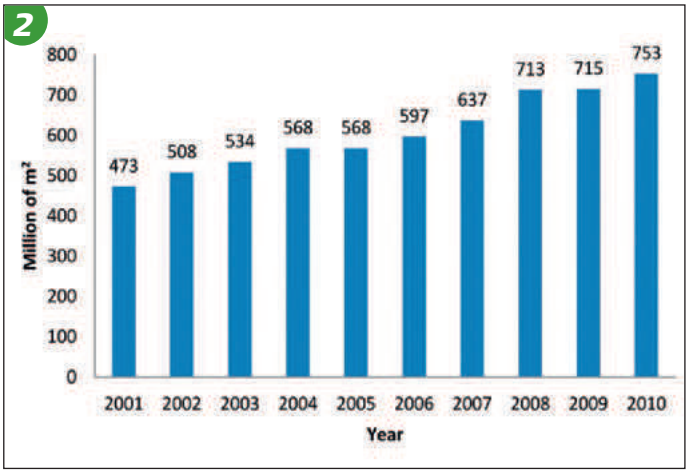

Fig. 2 • Production of ceramic tiles in Brazil during the decade 2001–2010 [3]

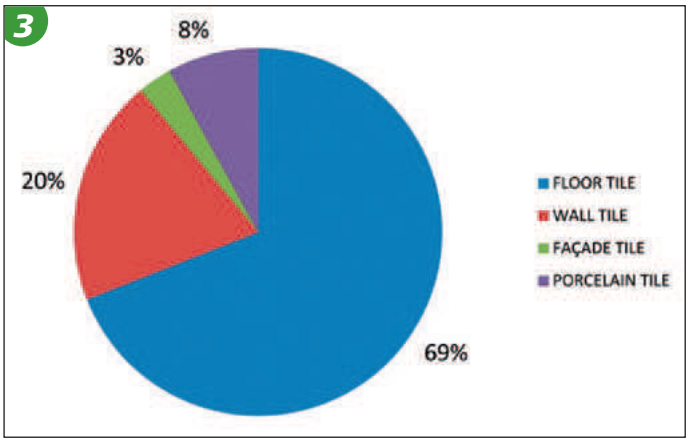

Fig. 3 • Production of ceramic tiles by type [4]

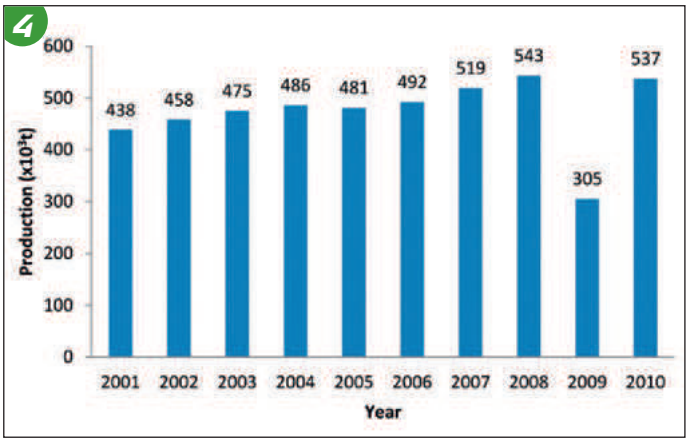

Fig. 4 • Evolution of Brazilian refractory production during the decade 2001–2010 [6]

3 Ceramic tiles

At present Brazil is the second largest producer of floor and wall tiles. It is also the second largest consumer of these tiles in the world, after China. In the last few years this sector has been trying hard to grow and overtake traditional producers like Italy and Spain (Fig. 1 [2]).

The production of floor and wall tiles reached around 753 million m^2 in 2010, a marked increase in the last decade (Fig. 2 [3]). The products of this sector can be divided into floor tiles, wall tiles, facade tiles and porcelain tiles, as shown in Fig. 3 [4].

The Brazilian ceramic tiles sector consists of about 100 factories in 18 states, although 80 % of the overall production is in regional ceramic centres in Santa Catarina and São Paulo. In recent years, tile manufacturing using the dry process has increased compared with the traditional wet process, mainly in the São Paulo region, and in 2009 it corresponded to 69 % of the production. In 2008 the ceramic tiles industry had 23,893 direct employees and a turnover of around US$ 3.3 billion. Even though the market is growing rapidly, internal and external competition, notably from China, and the unfavourable exchange rate has reduced the average price, even with the marked increase in the price of the more expensive products like porcelain tiles.

4 Refractory materials

The Brazilian refractory sector has over 30 companies, and these are concentrated in the south eastern region and provide about 6000 jobs. Among these, the largest company caters to more than half the market and the four largest companies of this sector produce over 80 % of the Brazilian output, as shown in Table 2 [5].

Refractory consumption in Brazil is mainly in the metallurgical industry. The consumption of refractories in the main industrial sectors and the specific consumption of each sector in Brazil are shown in Table 3 [5].

In spite of a sharp drop in industrial consumption of refractories, due mainly to new product, equipment and process technologies, refractory production has increased, and this was caused by growth of the industries in Brazil. As a point of reference, if 50 years ago 30 kg of refractory was necessary to produce a ton of steel, today the more modern plants consume 9 kg/t.

In 2010, refractory production was 537 thousand tons compared to 438 thousand tons in 2001 and this represents 2.3 % growth a year during this period (Fig. 4 [6]). This contrasts with the marked drop in specific consumption of refractory materials. The productivity of this sector is between 150 and 250 tons/man/year and varies a lot as a function of the product mix of this industry.

Table 1 • Information about Brazilian structural ceramics [2]

Product	Approximate number of companies	% of sector	Production / pieces/ month x 10^6	Clay consumption / t/month x 10^3
Blocks/bricks	4820	63	4000	7800
Roof tiles	2509	36	1300	2500
Tubes	12	0.1	325.5 km	–

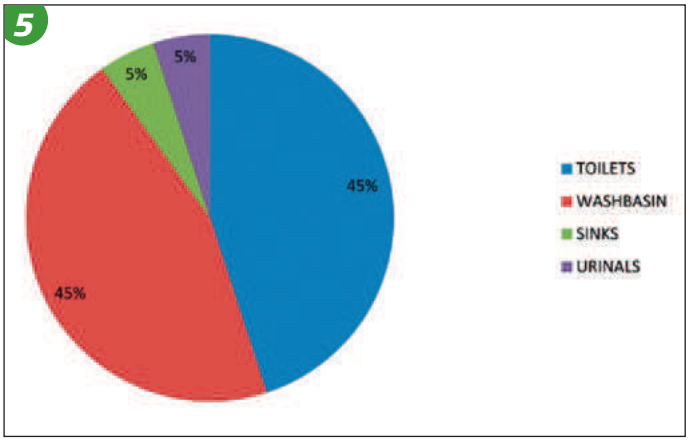

Fig. 5 • Distribution of sanitary ware pieces by type of product [8]

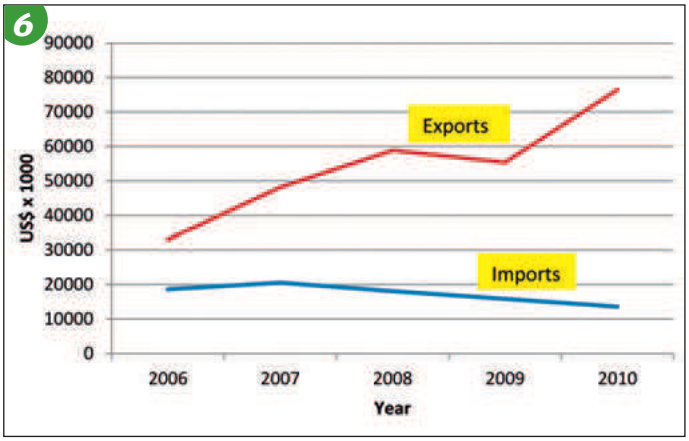

Fig. 6 • Evolution of trade balance of the tableware sector from 2006 to 2010 [10]

Table 2 • Market share, refractories companies [5]

Company	Market share / %
Magnesita	55–60
Ibar	10–15
Saint Gobain	5–10
Vesuvius	5–10
Others	10–15

Table 4 • Information about Brazilian sanitary ware companies [8]

Number of companies	10
Number of factories	18
Production / pieces/year	21,000,000
Installed capacity / pieces/ year	25,000,000
Share of two of the largest companies (Deca and Rocca)	65 %
Number of direct employees	7500

Table 3 • Refractories consumption in Brazil [5]

Sector	Share of refractory consumption / %	Average specific consumption / $kg_{refractory}/t$
Iron and steel industry	70	10–13 (integrated)
		6–11 (electrical)
Cement and lime	8	0.7–0.9
Non-ferrous metallurgical industry	7	11–14 (aluminium) 40–70 (nickel) 4–10 (copper)
Foundiries	5	10–20
Glass	3	5
Chemical and petrochemical	2	7 / kg/millions of barrels
Others	5	–

Table 5 • Geographical distribution of the sanitary ware industry [8]

State	Unit-City	Companies
Paraíba	João Pessoa (2)	Santa Aliança Deca
Pernambuco	Recife Caruau Cabo de Sato Agostinho	Rocca Luzarte Deca
Espírito Santo	Serra	Rocca
Minas Gerais	Santa Luzia Andradas Poços de Caldas Araxá	Rocca Icasa, Fiori Togni Santa Clara
Rio de Janeiro	Nova Iguaçu	Deca
São Paulo	Jundiaí Taubaté Itupeva	Deca (2), Rocca Hervy IDT Banheiras
Rio Grande do Sul	São Leopoldo	Deca

Large refractory consumers like the steel and cement industries, which consume 70 and 8 %, respectively, have grown rapidly in the last few years, and the projections for the next decade are encouraging. This growth in the Brazilian market has motivated foreign companies to compete with Brazilian companies, strengthened even more so by the favourable exchange rates. Nevertheless, the trade balance of this sector is positive due to exports.

5 Sanitary ware

Brazil is among the largest producers of sanitary ware in the world, along with China, Mexico, Turkey, Bulgaria and Russia. Today more than 20 million pieces are produced, sustained mainly by growth of the internal market, as exports have diminished from a record 20 % of the production to 10 %. The Brazilian production that was 2 million pieces/year in 1960 grew to 13.7 million pieces/year in 2000 and to 21 million pieces in 2008 [7, 8]. The pieces produced consist of washbasins, toilet bowls, sinks and urinals (Fig. 5 [8]).

This sector has 7500 employees and its productivity is 5,640 pieces/man/year. This sector consists of 10 companies that jointly have 18 production units, and the two main companies produce about 65 % (Table 4 [8]). Initially the production was concentrated in the south eastern region of Brazil, mainly in São Paulo, but since 1970 due to gradual decentralization there are now production units in eight Brazilian states.

6 Tableware

The tableware sector's characteristic is that it is made up of mainly small companies located in southeast Brazil, in centres like Pedreira, Porto Ferreira, Andrades and Campo Largo. It is estimated that there are over 500 tableware making companies, of

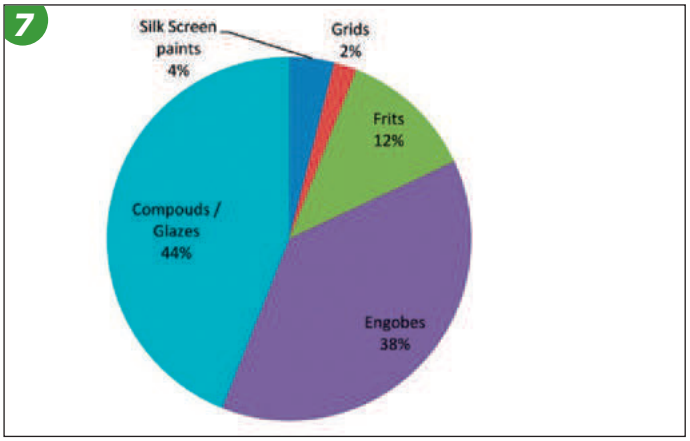

Fig. 7 • Production of glazing agents by type of product [11]

which 300 are in the state of São Paulo. This sector produces 200 million pieces a year. Table 6 [9] shows the tableware production of the main companies or industrial parks in Brazil. Tableware constitutes a variety of products like dinner sets, tea sets, vases, statues, domestic utensils, carrying cases, decorative items, etc.
Historically this sector exported 10 % of its production, mainly to South American countries and Portugal. At present this quantity does not exceed 2 %, due to competition from Chinese products and unfavourable exchange rates. Besides this, the entry of Chinese products in the Brazilian market has had a negative effect on the results of the Brazilian companies that are operating at less than 60 % of their installed capacity. Figure 6 [10] shows the evolution of the trade balance of this sector during the previous years.

7 Frits and glazes

The frit is the main product of the ceramic glazing industry and is sold as it is, or is added to other natural or synthetic raw materials and sold compounds, engobes, grids and silk screen paints (Fig. 7 [11]). The vitreous glazing industry in Brazil produced more than 500 tons in 2010 (Fig. 8 [11]), a 100 % increase in the last decade, considering that the production in 1999 was 230 thousand tons.
There are 17 companies in Brazil and most of these are close to two large industrial complexes: São Paulo state (region of Santa Gertrudes) and Santa Catarina (region of Criciúma). Expansion of the ceramic glazing industry depends directly on the ceramic tile industry, which is the largest consumer of frits and by-products and as shown earlier, a substantial growth of this sector in foreseen.
The turnover of this sector in 2008 was US$ 700 million, between frits and its by-products. Ceramic glazing companies have created 2500 jobs and the output of this sector is 200 tons/man/month [11].

8 Glasses

The production of the glass industry in Brazil in 2009 was 2.4 million tons and its installed capacity was 3.4 million tons. That year, the turnover of this sector was US$ 3.0 billion and it provided 12 thousand direct jobs. Flat and packaging glasses constituted almost 90 % of the production and the rest was made up of household glasses (plates, cups, vases, etc.) and industrial glasses (lamp bulbs, roof tiles, TV tubes, etc.) [12]. The production of flat glass is done mainly by multinational companies of the Cebrace sector, joint ventures of giants like NSG-Pilkington and Saint-Gobain that have four factories, and Guardian with two manufacturing units. Packaging glasses are produced by the American company Owens-Illinois which acquired Cisper, and recently CIV and Saint Gobain (Santa Marina), and these account for 87 % of the pro-

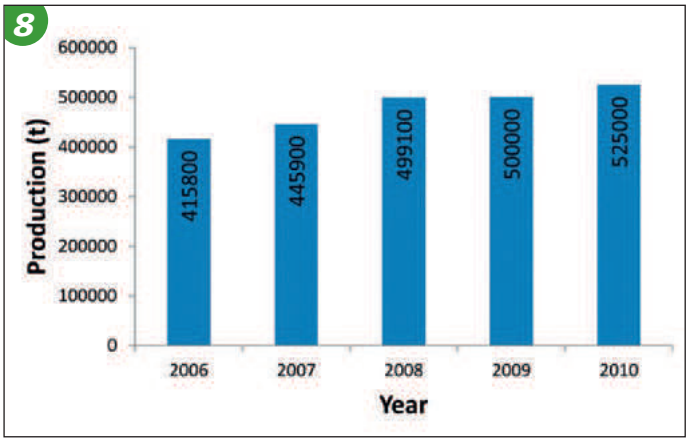

Fig. 8 • Production of the ceramic glazing industry from 2006 to 2010 [11]

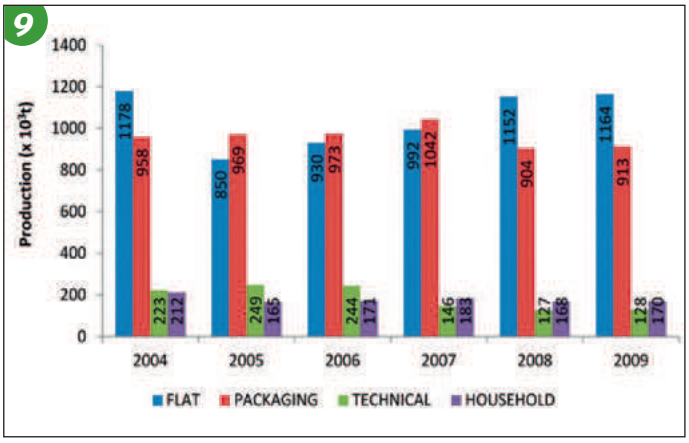

Fig. 9 • Production of the Brazilian Glass Industry from 2004 to 2009 [13]

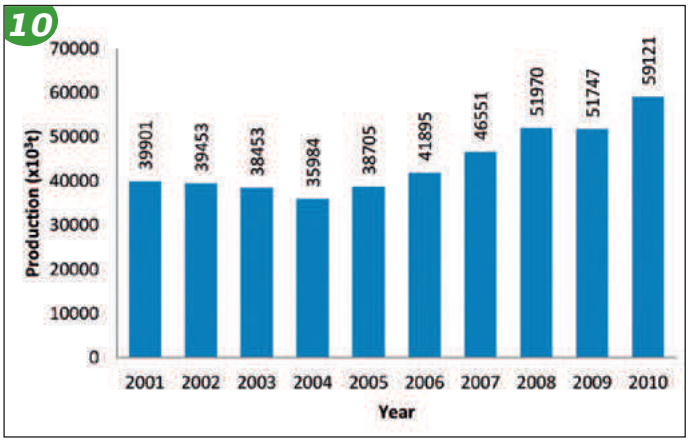

Fig. 10 • Production of Portland cement in Brazil 2001–2010, [16, 17]

duction. In the household glass sector, 78 % is produced by Nadir Figueiredo, Saint-Gobain (Santa Marina) and Owens-Illinois (Cisper).

The per capita consumption of glass in Brazil is low. It is 12.1 kg/person compared to the world average of 19 kg/person. Within the different segments of this sector a marked increase in flat glass production is foreseen, based on increase in demand in the automobile and the civil construction industries (Fig. 9 [13]). The flat glass sector is expected to increase production, having set up new factories: CBVP (Brazilian Plane Glass Company) in Pernambuco in 2012 with Brazilian funding and a new unit of Cebrace in Bahia in 2013 [14].

9 Portland cement

Brazil is the eighth largest producer of cement in the world, which is 1.7 % of the world's production. In Brazil there are 12 large industrial groups and these have 75 plants spread out in 23 states and in the federal district. These include 51 integrated plants and 24 milling units. The demand for cement is so high that the construction of at least 15 new plants is foreseen until 2014, and these plants are expected to increase considerably the overall production capacity of this sector in Brazil [15].

The number of employees in the cement industry increased from 19 thousand in 2004 to 23 thousand in 2007, a growth of 21 % [16]. Figure 10 [16, 17] shows the production of cement in the last decade.

Table 6 • Largest producers of table ware [9]

Company (industrial park)	Units (location)	Production / pieces/year
Schmidt	Pomerode (SC)/Mauá (SP)/ C. Largo (PR)	30,000,000
Oxford	São Bento do Sul	50,000,000
Pozzani	Jundiaí (SP)	12,000,000
Polo Campo Largo	Campo Largo (PR)	30,000,000
Polo Porto Ferreira	Porto Ferreira (SP)	30,000,000
Polo Vista Alegre	Vista Alegre (RS)	2,500,000
Polo Pedreira	Pedreira (SP)	36,000,000
Polo M. Sião/Andradas	Monte Sião/Andradas (MG)	?
Total		**~200,000,000**

10 Teaching and research

Brazil has some centres of excellence in research and development of ceramic materials and to train manpower. Historically these research centres and universities were mainly in the southeast of Brazil. However, in the last few years, knowledge dissemination and new centres have emerged in Brazil, as described by Salomão et al. in a recent publication [18]. The main forum for exchange of ideas and interaction in the ceramic area has been the Brazilian Ceramic Congress, which this year is the 57th in its series. Other Brazilian conferences and seminars have ceramics as part of their focused topics besides the large number of business fairs listed in these publications.

11 Final remarks

As per the Mines and Energy Ministry (MEM), the non-metallic transformation sector includes the ceramic industry and it contributes 0.75 % towards the GDP of Brazil and 3.75 % towards the industrial GDP. This sector has high temperature processing and consumes 3.8 % of the energy consumed in Brazil and 7.7 % of the industrial energy consumption. However, it is an important sector in terms of creating jobs, and in 2009 it created 367 thousand jobs [17].

The ceramic industry, except for the cement and red ceramic industries that are spread out across the country, is concentrated in the south and south-eastern regions of Brazil as shown in Fig. 11.

All the sectors that have been mentioned in this article, except the tableware sector, are directly related to civil construction and are expected to grow during the next decade for reasons mentioned earlier.

In terms of industrial capacity, most of the sectors mentioned in this report and more

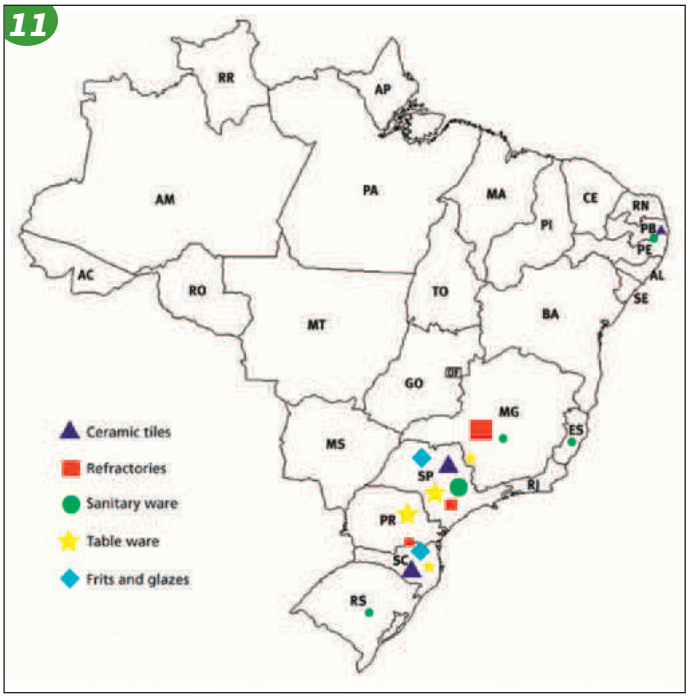

Fig. 11 • Geographical distribution of some sectors of the Brazilian ceramic and refractory industry

so the cement, glass, tile and refractory sectors have modern industrial parks. Nevertheless, a shortage of specialized manpower is foreseen in these sectors, because demand exceeds supply, especially at the technician level, in spite of the existing centres of excellence in teaching and research.

References

[1] **Bressiani, J.C., Bustamante, G.:** The Brazilian ceramic industry. Interceram **49** (2000) 41–48
[2] National Association of the Ceramic Industry (ANICER), http://www.anicer.com.br
[3] National Association of the Ceramic Tiles Industry (ANFACER), http://www.anfacer.com.br
[4] **Cabral Jr., M., Boschi, A., Motta, J.F.M., Tanno, L.C., Sintoni, A., Coelho, J.M., Caridade, M.:** Panorama e Perspectivas da Indústria de Revestimentos Cerâmicos no Brasil. Cerâmica Industrial **15** (2010) [3] 7–18
[5] **Lobato, E.:** Technical Report 71, Refractories, Ministry of Mines and Energy (MME) (2009), http://www.mme.gov.br/
[6] Latin America Association of Refractories Producers (ALAFAR), http://www.alafar.org
[7] **Cabral Jr., M., Tanno, L.C., Motta, J.F.M., Ruiz, M.S., Coelho, J.M.:** Panorama da Indústria de Sanitário no Brasil. Cerâmica Industrial **15** (2010) [3] 12–18
[8] **Tanno, L.C., Cuchierato, G., Motta, J.F.M., Cabral Jr., M., Sintoni, A., Machado, S., Yokota, R.:** Perspectivas para a Indústria Cerâmica de Sanitários no Brasil. Cerâmica Industrial **8** (2003) [4] 33–36
[9] **Ruiz, M.S., Tanno, L.C., Cabral Jr., M., Coelho, J.M., Niedzielski, J.C.:** A Indústria de Louça e Porcelana de Mesa no Brasil. Cerâmica Industrial **16** (2011) [2] 29–34
[10] Syndicate of Tableware of the São Paulo State (SINDILOUÇA), http://www.sindiloucasp.org.br
[11] **Cabral Jr., M., Boschi, A.O., Ferreira, L.B., Coelho, J.M.:** A Indústria de Colorifícios no Brasil: Situação Atual e Perspectivas Futuras. Cerâmica Industrial **15** (2010) [1] 13–18
[12] **Rosa, S.E.S, Cosenza, J.P., Barroso, D.V.:** Glass Brazilian Industry, Development Nacional Bank BNDES- Sectorial Report **26** (2007) 101–138, www.bndes.gov.br/SiteBNDES/export/../bndes.../bnset/set2605.pdf
[13] Abividro Annual Report 2009: Brazilian Technical Association of Automated Glass Industries (ABIVIDRO)
[14] Brazilian Technical Association of Automated Glass Industries (ABIVIDRO), http://www.abividro.org.br
[15] Brazilian Association of Portland Cements (ABCP), http://www.abcp.org.br
[16] National Syndicate of Cement Industry (SNIC), http://www.snic.org.br
[17] Statistical Annual Report 2010: Non-Metalic Sector, Brazilian Ministry of Mines and Energy (MME)
[18] **Salomão, R., Wakamatsu, M.J., Ferreira, E.B., Arantes, V.L.:** Ceramics in Brazil: Opportunities and Challenges for Education and Research. Interceram **60** (2011) [6] 351–360

Received: 16.07.2012