ADVANCED CERAMICS IN BRAZIL

A. O. Boschi[1] J. Duailibi Filho[2] and J. C. Bressiani[3]

[1] Departamento de Engenharia de Materiais - UFSCar
Postal Box 676 ; São Carlos - SP - Brazil
[2] Instituo Nacional de Technologia - INT
Av. Venezuela 82, Rio de Janeiro - RJ - Brazil
[3] Instituto de Pesquisas Energéticas e Nucleares - IPEN
Campus da USP, São Paulo -SP - Brazil

INTRODUCTION

The aim of this work is to present a critical analysis of advanced ceramics in Brazil today and, based upon it, comment on the future, as we see it. To achieve this, we start with a very short historical view to give a brief idea of how we came to be what we are today on advanced ceramics.
From the beginning we would like to apologise for not mentioning names and facts that certainly have played major roles on the development of ceramic materials in Brazil. To minimise this we have avoided mentioning names and dates and used instead facts and periods. All the statements presented bellow are generalisations needed to develop the argument we are trying to put forward and we hope those who do not agree with these general views will forgive us for not mentioning their particular opinions.

FROM TRADITIONAL TO ADVANCED CERAMICS

Archaeologists have found in Brazil ceramic objects dating from 10000 years ago. However, ceramics for more technical applications, such as bricks and tiles, as well as the technology of making them, basically came from Europe with the colonisers during the XVI century. During the following centuries Europeans continue to come to Brazil and brought with them the latest developments. Under these circumstances there was little room for the development of a Brazilian ceramic technology and, in general, we became mere consumers of ceramic technology which has been generated somewhere else.
During this period ceramic technology was not taught in schools but transmitted from fathers to sons and, sometimes, from masters to chosen apprentices. All knowledge was kept as a very special secret from which an individual and his family would earn a living.
In the forties and fifties some Brazilian universities were already producing Chemists and Chemical Engineers. Some of the lecturers and researchers somehow related to these universities, realising, on one hand, the economical importance of the area, and, on the other, the urgent need for a better understanding of the processes involved on producing this sort of material choose to work with ceramics. At this time, and mainly the two following decades, raw materials were the main concern and a huge effort was made to characterise those already been used and to look for new ones. However, anybody wanting to get a degree on ceramics would still have to go abroad. In the fifties the Chemical Engineering Department of the Universidade de São Paulo was the first to have post graduation lectures on ceramics. A few years latter came the first post graduation thesis on ceramic materials, almost always related to raw materials.

In 1970 the Brazilian government has founded a new University near the geographical centre of São Paulo state at São Carlos. Together with the new University started the first Materials Engineering course of all South America. Given the novelty of the course it was planned to cover three areas of knowledge: metals, ceramics and polymers. The students could choose one of the areas. So, this was the first graduation course to teach ceramics as a subject, aiming towards producing professionals to work with ceramic materials.
Meanwhile, some of the researchers of the Chemical Engineering Department of USP started to work with alumina.

THE BRAZILIAN CERAMIC SOCIETY (ABC)

The Brazilian Ceramic Society was founded in 1953 and since then has been a permanent forum for debates of subjects related with ceramic materials. The ABC organises every year The Brazilian Ceramic Conference and publishes a magazine named CERAMICA, which has been published for 41 years. Figure 1 shows the number of paper presented at The Brazilian Ceramic Conference since 1986.
In 1986 the ABC created the Advanced Ceramics Committee which has played a major role on promoting interactions between institutions working with this materials and also advising the government on stabilising policies for the area.

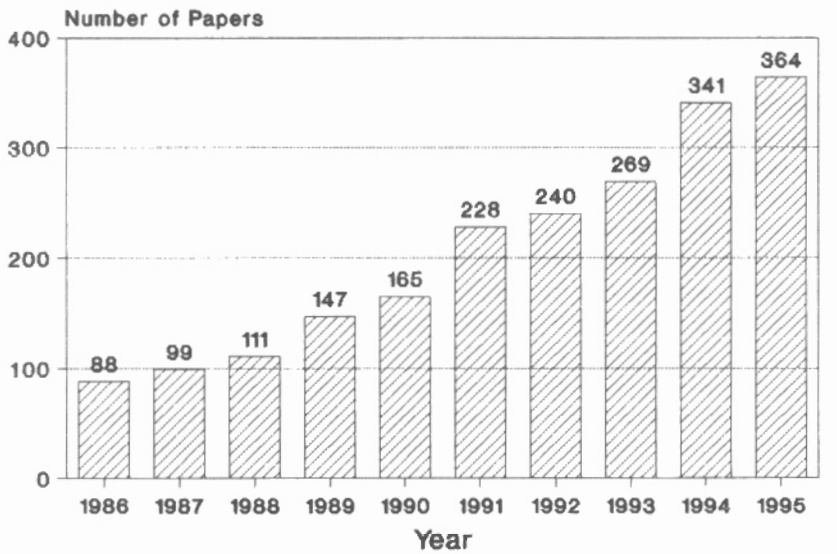

Figure 1: Number of papers presented at The Brazilian Ceramic Conference.

EDUCATION ON ADVANCED CERAMICS

Technical Schools
There are three technical schools teaching ceramics in Brazil. All of the give a degree corresponding to the second level, what means the level just before the university. All of

them are closely related to the industrial sector and the emphasis is on traditional ceramics.

Graduation(2)
Brazil doesn't have graduation course on ceramics. At university level, the only course with a considerable emphasis on ceramics are the Materials Engineering courses. Regardless of the relatively small number of lecturers with a doctors degree on ceramics, there has been a very fast increase in the number of Materials Engineering Courses in the last few years. At present there are about 5 Materials Engineering courses in Brazil. Some of these are renewed editions of traditional Metallurgical Engineering and some are brand new courses and almost all of them are somehow based on São Carlos's experience and therefore divide the content in ceramics, metals and polymers.
The emphasis in all these courses is on advanced ceramics and they have produced about 200 engineers up to now.

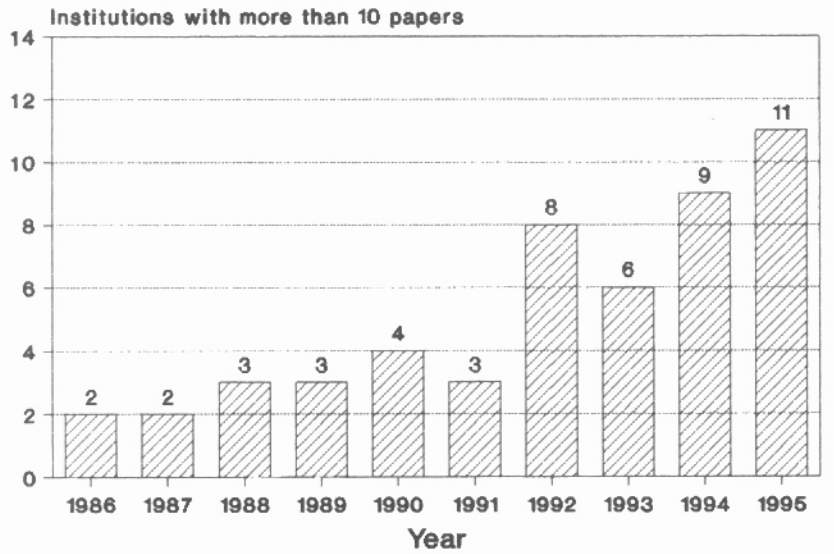

Figure 2: Number of institution presenting 10 papers or more at The BrazilianCeramic Congress since in the last 10 years.

Post-Graduation(2)
At post-graduation level there are about 11 courses forming masters and doctors with researches related to ceramic materials. Almost all of them emphasise advanced ceramics.
Apart from this, some post-graduation students working with ceramics go abroad to get their degrees. To give an idea of the number of post-graduated professionals specialised on ceramics, from 1990 to 1993 the 11 post-graduation courses in Brazil and those send abroad have produced 133 and 34 masters and doctors thesis, respectively. Almost all of them on advanced ceramics.

In conclusion, Brazil do have a reasonable number of graduated and post-graduated professional ready to work with advanced ceramics.

RESEARCH ON ADVANCED CERAMICS

In the last few years the Brazilian government has spent quite a reasonable amount of money to assembly laboratory facilities capable of working with advanced ceramics. The research production of these institutions usually became papers at The Brazilian Ceramic Conference. Therefore we have used the conferences programs of the last 10 years to evaluate the evolution of research activities on advanced ceramics. Figure 2 shows the number of institutions which have presented 10 papers or more at The Brazilian Ceramic Conference in the last 10 years. As can be seen there has been quite a considerable increase in the number of institution with a reasonable capability of doing research. From the 11 institutions presenting 10 papers or more at The Brazilian Ceramic Conference in 1995, at least 8 work mainly with advanced ceramics.

At the 1995 Conference, in total, there were 71 different institutions presenting papers. From this 27 were industries and 44 research institutes and universities. A total of 25 papers were done together by industries and public research institutions and 19 were done by industries alone.

These number confirm the results of the investments, mentioned above, for creating laboratory facilities to work with advanced ceramics and lead to the conclusion that there is quite a reasonable number of institutions capable of doing research on advanced ceramics.

MANUFACTURE OF ADVANCED CERAMICS

The market for advanced ceramics in Brazil in 1988 was estimated as US$ 250 millions (1). The same study suggested an annual growing rate of 14%. Therefore it was estimated that by 1995 the Brazilian market for advanced ceramics would be US$ 625 millions and by the year 2000 US$ 1,2 billions.

Today, as in 1988, there are about 25 companies manufacturing advanced ceramics products in Brazil. Some of the most relevant are: NGK (spark plugs and other alumina products), Bosch (spark plugs), Thomson-CSF (electronic components), Rohm (electronic components), Constanta(electro-magnetic components), Pirelli (optical fibers), Corning (special glass products), ABC-XTAL (optical fibers), VC Varistores (electronic components), Cerauto (electronic components), Lorenzetti (electronic components), Balestro (electronic components), Certronic (electronic components), Thornthon (electronic components) and Mitec (electronic components). Apart from these, there are about a dozen small and medium size companies manufacturing products such as wire-guides, crucibles, tubes, mechanical seals and nozzles, etc..

Apart from the companies mentioned above, there are also those producing raw materials for the advanced ceramic industries. Among these some of the most relevant are: Alcoa (alumina), Alcan (alumina), Carborundun (silicon carbide), Tibras (titanium dioxide), CVRD (high purity quartz), Uniroyal (zinc oxide), CBMM (niobia) and QGN (barium carbonate).

Despite the reasonable number of companies involved with the manufacture of advanced ceramics, in the last few years the total market for their products, in general, didn't grow as the forecast, mentioned above, have predicted. Under these circumstances companies such as NGK, as an example, have stopped the production of quite a few of its advanced ceramic products, and suspended the introduction of new items, and concentrated at just

a few products which at best could be classified as technical ceramics. The only sectors which has grown in certain areas are those related to refractories and electro-magnetic ceramics. In general it is believed that the market for advanced ceramics in Brazil didn't grow considerably since 1988 and is something of the order of US$ 300 millions today.

IS THERE A FUTURE FOR ADVANCED CERAMICS IN BRAZIL ?

We think the answer to this question is yes. Below we will try to present some of the reasons why we believe there ought to be a future for advanced ceramics in Brazil.
To present some relevant aspects we have chosen three areas in which we believe the knowledge related to advanced ceramics could play an important role in the future of the country:

1-) markets which are too small for international corporations,

2-) areas in which the international prices are too high for Brazilian standards,

3-) application of advanced ceramics technology to improve the quality of traditional ceramics

Relatively Small Markets

There are quite a few application of advanced ceramics which do not represent a market big enough to catch the attention of the large international corporations. Nevertheless, for small and medium size companies these may be quite attractive markets.
The knowledge of the peculiarities of the country and the uses of its population create another differential factor which may allow Brazilian products to win the competition with international ones. This sort of inside information is very useful when dealing with local markets and the South Cone Common Market.

Products Considered Expensive for Brazilian Standards

A strong component of the price of products is how much the consumer can afford paying for it. This value will certainly chance from one country to another and will almost always make products manufactured in developed countries unaffordable for the largest parts of the population of less developed countries. In these cases the costs of manufacturing the products does not play an important role on the determination of commercialisation prices. Most of the time these products can be manufactured in Brazil and yeld quite a reasonable profit even when sold at prices compatible with Brazilian standards. Unfortunately however, most of the time, the prices of new Brazilian products which try to substitute imported ones, are fixed by taking into consideration the prices of the imported products. This procedure is responsible for the very high prices of some products which are certainly not so expensive to make. It is necessary, when fixing the prices of products, also to consider aspects such as the costs of manufacturing, the wealth of the population and the benefits that the product will bring. As an example, we could mention biomaterials which are just one type of product which has gone through what was described above

Traditional Ceramics

With the increasing tendency for a global economy there has been a sort of a division of markets that belong to advanced countries and to less advanced countries. Brazil is in this second category. The international markets left to these countries, most of the time,

are related to moderated to low technology products. However, these markets are quite big and it is worth fighting for them. Otherwise we will perpetuate our position as a less developed country. The number of countries disputing these international markets is considerable and competition is quite tough. To increase the chances of winning this competition, there has been a tendency, in the last few years, of turning these products of moderate to low technology products in quite sophisticated artefacts. The need for ever better quality, lower prices and continuous innovation, which gives the competitivety of a product, has made it necessary to apply the theories and characterisation techniques originally developed for advanced ceramics to traditional ceramics, such as tiles, sanitary ware, etc. This approach has been successfully taken by some of our strongest competitors. It is time we do the same. However, to achieve this it is paramount that the Brazilian researchers and the institution that support their work, understand that at least a reasonable part of our research effort has to be directed towards answering the questions our industries are asking, even when somewhere else the answers to these same questions have been known for many years. If we manage to co-ordinate this two aspects and start to prize more what will solve our particular problems than what will solve the world problems we will certainly be moving towards achieving for ourselves a better place in the future.

Apart from the aspects mentioned above there are certainly many others.

FINAL COMMENTS

Brazil has also been affected by the so called ceramic fever. As a result of this influence we have today a considerable number of specialised personnel and laboratory facilities ready to work with advanced ceramics. Unfortunately however, the actual revenue of the advanced ceramics industry is not expressive and the projections for the near future are not very good. Nevertheless there are several possible uses for this potential which will enhance the competitivety of products in international markets and considerable benefits to our population.

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