MCDCM

MULTIDISCIPLINARY CENTER FOR THE DEVELOPMENT OF CERAMIC MATERIALS

REPORT 3

PARTIAL REPORT OF THE MCDCM ACTIVITIES COVERING THE BASIC RESEARCH AND TECHNOLOGICAL RESULTS AND EDUCATIONAL ACTIVITIES

PERIOD FROM OCTOBER 2002 TO OCTOBER 2003

OCTOBER 31, 2003

REPORT (3) – MCDCM

1. Overview

This report encompasses all the activities developed in the center during this third running year. This report shows that in this third year the activities of the center were as intense as in former year for all levels, including the scientific production, innovation activities as well as the continuous education and dissemination of knowledge to the society. As described in this report, in the third year the advances in the research projects was compared with former two years. The productivity of the majority of the groups has been improved year by year, demonstrating that the synergy of the groups by means of collaborations is the key factor. As stated in the former report, the collaborations among members of the center and with other researchers not belonging to the center in the national and international level can be extracted in this report. The members of the center have been published about 138 papers being 129 in international periodicals and about 9 in national periodicals. These numbers is considered very good if we consider that there was a modification in the research structure in the direction and staff of the Magnetic and Superconducting group. Considering the several research areas of the Research Division, the number of papers per area was: Chemical synthesis = 51; Semiconductors and Ferroelectric Materials = 50; Optical and Electrochromic Materials = 20; Crystal Growth and Non-Crystalline Materials = 10; and Design, Fabrication and Characterization of Microdevices Based on Magnetic and Superconducting Thin Films = 07. Figure 1 shows the relative productivity by research lines.

This high productivity of the center has been acknowledge by the international scientific community, since several leader members of the center have been invited to organize meetings or to give seminars and invited papers in international meetings related with ceramic materials. In this year a member of the center organized a Symposium for 2004 Spring meeting of MRS. In addition, 6 invited papers were given by members of the centers in international meetings, as well as 6 seminars were given in materials science departments all over the world. Moreover, one member received an international Epsilon prize from the Spanish Ceramic Society and two members of the center are members of the International Academy of Ceramics, being one of them member of the Advisory Board of the Academy.

The results in the Innovation Division of the Center are growing with other companies join to the center by means of technological research projects. One important factor is the satisfactions of the companies with the results of these join projects. This can be extracted by the fact that the great majority of the companies remain contracting projects with the center year by year. These achievements are related to the high motivation of several members of the center, as well as the excellent management of the center. Projects have been contracted by large companies like CSN (more than 13 years), White Martins/Praxair (6 years), CBMM (12 years); John Faber (2 years), as well as

by medium and small companies (Delamar, Albras, O Boticario, Cognis, among others) resulting only in this year the deposit of 7 patents. The results of projects with companies also resulted several awards given for their technical excellence contents, including the recent FINEP Prize for Technological Innovation (Brazilian Funding Agency for Technological Projects). Other indicative of the excellence of the work developed with industries, besides the technical solution for the companies, is the high number of join papers published with members of the companies (12). It should be also stressed that many projects with industries are well related with research line of members of the center. Many projects are related to Tin Oxide based ceramic, which has been studied extensively by the members of Center. In this sense, the degree of innovation is quite high. Tin oxide based varistors were developed by members of the center and has been considered for commercial applications by Delmar. The center is negotiating with the company for high voltage tin oxide varistor due to its high performance compared with ZnO varistor. Our studies in synthesis and doping of tin oxide also originate a project for production of semiconductor enamel for electrical porcelain. This project started last year and have exciting results for commercial applications. In the same way, the development of new methods for synthesis of nanosized niobium oxide for CBMM Company is in the stage of pilot plant for the company, which can compete in this growing market.

The continuous education and dissemination division of the center has increased and diversified the numbers of activities reaching a well-established program for the next years. In this sense, our program in this third year encompassed the diffusion through the lectures in elementary and high schools about several subjects related to the chemistry and physics of ceramic materials as well as the Ceramic Materials Educational Project, as described in the second report. Moreover, in this year was offered by the center a course on nanotechnology for undergraduate students from several universities. Many diversified activities like hosting teachers and high school students, basic courses for craftsman located in several locations, production of educational video, linking PhD students to industrial sector among others.

It should be emphasized that in this third year the interaction among research, innovation and teaching was consolidated. As example, the research results in nanostructured materials or nanoparticulates were transferred to the industry (CBMM, CSN and Faber Castell). Moreover, educational materials regarding these achievements, such as 3D video were produced and divulged by means of the media (TV, journal and radio) as well as in the elementary, high schools and colleges. Otherwise, the developments with the industries induced new ways for basic research leading to a great synergy among the members of the center and reaching the fundamental objectives of the Center, that is, bringing together the activities of research, innovation and diffusion of knowledge.

Finally it should be stressed that in this third year there was a restriction in the budget and in the disbursement due to international crisis and the money exchange

rate. As a consequence we were not able to purchase several imported equipment and the research direction of the center was changed.

1.2 – Team List

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C.A. PASKOCIMAS	UNESP	Ceramic Pigments
M. CILENSE	UNESP	Semiconductors and Ferroelectric Materials and Electroceramic Devices
J.O.A. PASCHOAL	IPEN	Continuous Education for Workers and Ceramic Tiles
R. MUCCILLO	IPEN	Intragranular phenomena in Ceramic Oxides Technology: Development of Ceramic Sensors
M.A. ZAGHETE	UNESP	Powder Synthesis
C.O. PAIVA-SANTOS	UNESP	XRD and Rietveld Method

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E.N.S. MUCCILLO	IPEN	Synthesis, microstructure and electrical properties of solid electrolytes
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B. STOJANOVIC	UNESP	Ferroelectric Materials
W.C. LAS	UNESP	Semiconductors
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S. SERGEENKOV	GMD / DF / UFSCar	Superconductivity; Josephson Effect

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- UFSCar/DEMa - Universidade Federal de São Carlos – Departamento de Engenharia de Materiais Educacionais IFSC/USP – Instituto de Física de São Carlos – Universidade de São Paulo – São Carlos

- IPEN – Instituto de Pesquisas Energéticas e Nucleares Nucleares - Centro de Ciência e Tecnologia de Materiais

- UFSCar/GMD - Universidade Federal de São Carlos – Grupo de Supercondutividade e Magnetismo

- UFSCar/DEME - Universidade Federal de São Carlos – Departamento de Ensino e Métodos Educacional

1.3. Results of the Research Division (Basic Research)
List of International and National Publications

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5. "*Photolumiscence in amorphous $YNiO_3$ and $La_{0.5}Nd_{0.5}NiO_3$ systems*" Z.R. SILVA, J.D.G. FERNANDES, D.M.A. MELO, C. ALVES JR., E.R. LEITE, C.A. PASKOCIMAS, E. LONGO, M.I.B. BERNARDI, Materials Letters, 56, 232-237 (2002).
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1.4. Results of the Innovation Division

INNOVATION	RESEARCH SUBPROJECT	SITUATION
Development of a semiconducting enamel for application in the electric insulator surfaces; As a result of this development the company is able to compete in the international market.	Santana Project	Concluded
Development of high performance monolithic refractory based on amorphous silica for application in the lining of the glass furnace crown and walls. The developed refractory is under testing in an industrial glass furnace for characterization of its performance. Brazilian Patent (PI 0302688-4, June 26, 2003)	White Martins-PRAXAIR/ FAPESP Project	Concluded
Fabrication of Solid Electrolytes for Oxygen Sensors in Molten Steels Actual Situation: A process for avoiding cracks in ceramic sensors for oxygen monitoring during fabrication of special steels has been developed. The sensors show high resistance to thermal shocks at temperatures as high as 1600^{o}C.	INDUSTRY 1	Concluded
Development of a Process for the Cleaning of Foundry Sands.	Marchesan	Concluded
Development of a Methodology for the Composition Determination of Oxalic Acid – Based Raw Materials.	CBMM	Concluded
Study on the Surface Behavior in Oxide-Based Raw Materials for the Cosmetic Industry	Boticário	Concluded
Study on the Processing Parameters Related to the Retention of CO2 and H2O in Niobates.	CBMM	Concluded

Improvement of Refractory Lining of Blast Furnace Hearth Based on the former project of Blast Furnace Hearth, it is proposed an improvement of the refractory lining by the chemical deposition of ceria and zirconia on carbon blocks of the Blast Furnace # 3 Hearths for enlarging the hearth campaign and also a process for the recovering of carbon blocks of the Blast Furnace Hearth. **U$ 4,800,000.00**	CSN	Concluded
CORROSION PROTECTION MECHANISMS OF THE Al_2O_3/SiC/C/$MgAl_2O_4$ REFRACTORY LINING USED IN TORPEDO CARS Post Mortem study of refractory lining ASCMg used in Torpedo Cars at CSN was realized with the objective of determining the mechanism of the corrosion developed during the industrial application.	CSN	Concluded
New desulfurization mix for reducing the sulfur content of pig iron In the current context of the integrated steelworks installed in Brazil, the actual operational practice of the blast furnace aims at improving the desulfurization rate of the pig iron. **U$ 2,800,000.00**	CSN	Concluded
Evaluation of the refractory lining of the ignition furnace of the sinter plant # 4 of CSN The project aims at the evaluation of the refractory linings of the CSN Ignition furnace of the sinter plant #4. **U$ 5,200,000.00**	CSN	Concluded

Development of industrial process for production of nanoparticles of niobium oxide for application in electronic ceramics, using a clean chemical route.	CBMM	Under Development
Development of industrial process for production of nanoparticles of niobium oxide for application in electronic ceramics, using spray pyrolysis Brazilian Patent (PI 0103280-1, 9 Aug. 2001).	CBMM	Under development
Development of high voltage ZnO varistor. The objective is to characterize the raw materials, optimization of the processing conditions and formulation of the varistor composition.	DELMAR Ltda	Under development
Development of Temperature Sensors. Actual Situation: A prototype of a temperature sensor has been developed based on NTC perovskites. The main processing parameters for the reproducible fabrication of a batch Quantity of sensors is currently being studied.	INDUSTRY 2	Under Development
Study on the Behavior of the Al_2O_3-Cr_2O_3 and Al_2O_3-ZrO_2 Refractory Systems, Working in Close Contact with Molten Glasses, for the Production of Bio-Compatible Ceramic Fibers.	RCR	Under Development
Development of Translucent Alumina Pieces for the Industrial of dentistry Products	Tecnident	Under Development

Enhanced behavior of the torpedo car refractory by the nanoparticle impregnation technique. It was developed a cerium solution able to partially occupy the free pores in the microstructure of the Al_2O_3/SiC/C/M gAl_2O_4 refractory lining used in the torpedo cars.	CSN	Under Development
Influence of the Product Composition and Operational Parameters on the Taphole Mix Operational Performance The objective is to study the behavior of different taphole mixes under critical operational conditions, in order to optimize the performance of commercial products.	CSN	Under Development
Chemical defloculant synthesis	FAPESP	Concluded
Al_2TiO_5 composition chemically stable	CHR	Concluded
Engineering & Craftsmanship	ROCA	Concluded
Shear evaluation of concrete specimens	Scandelari Co.	Concluded
Electrofused refractory aggregates for cement kiln	Eufusa	Under development
Recycling of Ceramic Industry Waste	FAPESP	Under development
Ceramic processing of graphite	Faber Castell	Under development

PATENTS DEPOSITED During this year four patents were deposited and are described bellow: **(1) Title: Processing of Nanocomposite Catalyzes** Abstract: A new route for synthesis and preparation of structured catalyzes as nanocomposites, i.e., nanocomposite systems of transition metals (with particles of 1-50 nm) such as: Fe, Ni, Co and Ag, with high degree of dispersion in a mesoporous matrix of amorphous SiO_2. This process is based in the formation of a hybrid polymer of Si-O-C containing transition metal cations in the macromolecules. By means of a controlled pyrolysis process in a nitrogen atmosphere it is obtained a nanocomposite without the need of using a reducing atmosphere of hydrogen	**FAPESP**	**PI 0302027-4**

(2) Improved compositions of silica based refractory castable. Abstract: The present patent is related with improved compositions of silica based refractory castable, by means of the use of aggregates based on: vitreous silica and/or crystalline silica (quartz, tridimite and/or crystobalite) associated with special additions. This special refractory castable are made to be used as refractory lining and repair in: Glass furnaces (mainly crown), furnaces, general Iron foundry (trough and ladles), Coke Oven plant (mainly in repair castable) and in precision foundry (lining). These improved compositions based in several aggregates of silica and special additions, promote the increase of lining life, contributing for the increase of the continuos operation time of the equipment used in these applications	**FAPESP**	**PI0302688-4**

(3) Method to transform amorphous carbon in crystalline graphite in graphite mines using transition metal nanoparticles. Abstract: The performance of a graphite mine can be described by the obtained graphite mechanical resistance (bending resistance, tip breaking, etc) and by its graduation (mainly the blackness level). However, based on the usual production methods used in graphite mines, these two characteristics are difficult to be maximized simultaneously, that is, higher the mechanical resistance smaller is the blackness level. The degree of black in a graphite mine is related with the amount of graphite and the amount of amorphous carbon. As higher is the amorphous carbon, smaller will be the degree of blackness and higher is the mechanical resistance. The present invention has as main objective decrease the amount of amorphous carbon in a composition of the graphite based mine, by means of the transformation of this disordered material (amorphous carbon) into crystalline graphite. For this, it is proposed the use of nanoparticles (particles with 3 to 70 nm size) of transition metals such as Fe, Ni and Co. These particles will be generated during the sintering through the decomposition of a chemical compound, that is, the precursor raw material containing the proposed transition metals. With the transformation or conversion of amorphous carbon, is possible to intensify the blackness level of the graphite carbon mine, reducing the dispersion of both, the mechanical resistance and the blackness level.	**FAPESP**	**PI 0302339-7**

(4) Method to transform amorphous carbon in crystalline graphite in graphite mines using transition metal nanoparticles. Abstract: The performance of a graphite mine can be described by the obtained graphite mechanical resistance (bending resistance, tip breaking, etc) and by its graduation (mainly the blackness level). However, based on the usual production methods used in graphite mines, these two characteristics are difficult to be maximized simultaneously, that is, higher the mechanical resistance smaller is the blackness level. The degree of black in a graphite mine is related with the amount of graphite and the amount of amorphous carbon. As higher is the amorphous carbon, smaller will be the degree of blackness and higher is the mechanical resistance. The present invention has as main objective decrease the amount of amorphous carbon in a composition of the graphite based mine, by means of the transformation of this disordered material (amorphous carbon) into crystalline graphite. For this, it is proposed the use of nanoparticles (particles with 3 to 70 nm size) of transition metals such as Fe, Ni and Co. These particles will be generated during the sintering through the decomposition of a chemical compound, that is, the precursor raw material containing the proposed transition metals. With the transformation or conversion of amorphous carbon, is possible to intensify the blackness level of the graphite carbon mine, reducing the dispersion of both, the mechanical resistance and the blackness level.	**FABER CASTELL**	**Submitted**

PRIZES		
1) Finep Prize of Technological Innovation, category Research Institution, granted to MCDCM at October 2003.	FINEP	
2) Prize "CST Aciaria" (CST Steel Plant) from ABM, Brazilian Metals Association granted to the technical contribution "Desenvolvimento de Novas Rotas de Aplicação da Escória de Aciaria LD" (Development of New Routes for the Application of BOF Slag) presented at the 57th Annual Congress of ABM.	CSN	
3) Honorable Mention from the Brazilian Association of Expertness and Evaluations in the category Technical Expertness for Steelmaking Refractories at September 2003.	IBAPE	
4) Epison Prize given by the Sociedade Espanhola de Ceramica y Vidrio de Madrid, granted by J. A. Varela for the technical contribution in Electroceramics.	Sociedad Espanhola de Ceramica y Vidrio	

1.5 – Continuous Education and Dissemination Results

ACTIVITY	RESEARCH SUBPROJECT
"NANOPARTiCLES: OLD IDEAS WITH NEW USES" Prof. Dr. Edson Roberto Leite – Prof. Dr. Elson Longo Place: Winter School of Physics Department (DF/UFSCar) "TRANSMISSION ELECTRON MICROSCOPY: APPLICATIONS IN NANOTECHNOLOGY" Prof. Dr. Daniel Mário Ugarte and Daniela Zanchet (Laboratório de Microscopia – Laboratório Nacional de Luz Sincrotron) Place: VII Winter School of Physico-Chemistry and Analytical Chemistry (DQ/UFSCar) Mini-course "SINTERING STUDY BY THERMAL ANALYSIS" Prof. Dr. Jürgen Blumm (Netzsch Geratebau GmbH) Place: Materials Science Department Seminars "Simulation of Ceramics Materials" Prof. Dr. Juan Andres (Universitat Jaume I) Castellon-Espanha Place: Chemical Department (DQ/UFSCar) "Simulation of Semiconductors Oxides-SnO_2 and TiO_2" Prof. Dr. Armando Beltran (Universitat Jaume I) Castellon-Espanha Place: Chemical Department (DQ/UFSCar) "Nitrate Ceramics" Prof. Dr. Roger Marchand Universitè de Rennes - France Place: Chemical Department (DQ/UFSCar)	**Undergraduate and Graduate Level**

"Densification and Grain Growth of Advanced Tin Oxide Ceramics " Prof. Dr. Richard Bradt University of Alabama USA Place: Chemical Department (DQ/UFSCar) "Photoluminescence of titanates" Profa. Dra. Emmanuelle Orhan Universitè de Rennès – France Place: Chemical Department (DQ/UFSCar) "New Materials for a New Millenium" Prof. Dr. Elson Longo MCDCM/LIEC-UFSCar Place: Institut of Chemistry (IQ/UNESP-Araraquara)	
State of São Paulo – Materials Science Engineering Students Congress ***"CORROSION IN REFRACTORIES MATERIALS"*** Ph.D. Sidiney Nascimento Silva, Ph.D. Fernando Vernilli Jr MCDCM/LIEC-UFSCar Courses of 8 hours of classes **State of João Pessoa – Paraíba -** Universidade Federal da Paraíba **"New Materials for a New Millenium "** Prof. Dr. Elson Longo, Dr. Carlos Alberto Paskocimas, (MCDCM/LIEC-UFSCar) Courses of 8 hours of classes	

ACTIVITY	RESEARCH SUBPROJECT
The excellence of the activities of MCMDC has been recognized by the Brazilian radio, TV and written press. Several reports on such activities were publicized also with the objective of contributing to the diffusion, throughout the whole Brazilian society, of the science and technology developed by MCMDC. As examples of such public recognition and important diffusion support one can cite the newspapers: - O Imparcial, Araraquara, SP. - A Folha, São Carlos, SP. - A Tribuna, Sáo Carlos, SP. - Primeira Página, São Carlos, SP. - O Estado de São Paulo, São Paulo, SP. As for magazines: - Notícias, a magazine from FIESP and CIESP. - Pesquisa, from FAPESP, one of the most active R&D supporting organizations in Brazil - As for the TV, MCMDC can rely upon TV Company covering the whole Central Region of São Paulo state, produced as series of reports covering the activities of MCDCM and TV-Cabo Branco of the Paraíba and TV Ponta Negra of the Rio Grande do Norte who has been helping in the public diffusion of a series of MCMDC achievements, either related with its basic research, or related to the industrial use of technologies developed by MCMDC.	**Diffusion to the Public**

2 – Results in Basic Research

In the period from 2002 to 2003, it was observed a decrease in the total number of published paper in relation to the last period. The total number around 138 papers can suggest an equilibrium value. This smaller value, in fact is a direct consequence of the modification in the research structure, with modification in the direction and staff of the Design, Fabrication and Characterization of Microdevices Based on Magnetic and Superconducting Thin Films group. Besides, other factor such as a re-orientation of the chemical synthesis research focus to the nanotechnology must be responsible for this slight decrease.

Besides those problems, the research productivity (total number of paper) still is high and the quality of the publication is very good. It is important to point out that, the re-orientation of the projects was an important decision, resulting in news interaction with new groups, as well as in a new and promising research area (nanostructured materials), with significant results that is showed in the text bellow.

2.1 Chemical Synthesis

In this research area, we start the development of new synthesis route to process metal oxide nanocrystals. This new rout allowed for example, the synthesis at room temperature, of doped and undoped SnO_2 nanocrystals (particle size ranging from 1-3nm) with no thermal or hydrothermal treatment. To the best of our knowledge, this is the first time that the synthesis of doped and/or undoped SnO_2 nanocrystals at room temperature has been reported. This new synthesis method is based on the controlled hydrolysis and oxidation of Sn^{+2} in an ethanol solution. Another novel aspect of this method is the possibility of using surfactants, which may provide improved control over particle size. This method was applied also in the synthesis of CeO_2 and Pr doped CeO_2, and a similar result was observed. These works were recently submitted to the J. of Nanoscience and Nanotechnology, and are under analysis. In this period we start also a fundamental study about nanocrystal growth in colloidal dispersion. The crystal growth process in colloidal nanocrystal systems is usually associated with the Ostwald-ripening mechanism . However, experimental evidence indicating that another crystal growth process took place in a colloidal nanocrystal system at room temperature. This crystal growth process is based on grain rotation among neighboring grains, resulting in a coherent grain-grain interface, which, by eliminating common boundaries, causes neighboring grains to coalesce, thereby forming a single larger nanocrystal. This phenomenon was observed in SnO_2 nanocrystals (particle size ranging from 10 to 30 Å). Our HRTEM results revealed

the formation of chains and primary particles clusters resulting in a single large crystalline nanocrystal. The chain morphology showed preferential growth in the [001] direction, while the clusters grew preferentially in the [101] direction. These results, which indicate that the observed mechanism occurs typically on high-surface-energy planes, are congruent with the theoretical calculations. A group from Spain performed the theoretical calculation, consolidating the interaction between the CMDMC and the Universitat Jaume I. The results of this research were published in a letter in the Appl. Phys. Letters. Other results that prove the good interaction between our research group and the group of the Universitat Jaume I, is the work performed about SnO_2 nanoribbon growth. In this work it was used quantum mechanics calculation and HRTEM experimental results to explain way the SnO_2 nanoribbon growths in the (221) direction. The results of this research as published in a letter in the Appl. Phys. Letters.

Considering the synthesis of ferroelectric oxides, the main research topic was the crystallization study of amorphous $PbTiO_3$(PT) to crystalline PT. In this period we start a new synthesis process to synthesize lead-based perovskite nanoparticles, such as PT. This method, which apparently involves no hydrolytic reaction and is carbon and halide-free, is called the oxidant peroxo method (OPM) because it is based on the oxidation-reduction reaction between Pb(II) ion and water-soluble metal-peroxide complexes with high pH. This process results in an inorganic amorphous precursor that requires subsequent thermal treatment to promote crystallization of the desired phase. Lead titanate was synthesized by the OPM wet-chemical route though the dissolution of Ti metal in H_2O_2 followed by the addition of Pb^{2+} at high pH, resulting in a reactive and amorphous precipitate with (Pb:Ti=1:1) mole ratio, which was heat treated in the range of 400 to 700 ºC. The amorphous precipitate was characterized by DSC, and all of the powders were characterized by X-ray diffraction, Raman and XAS (EXAFS and XANES) spectroscopy at the Ti K edge. A metastable, stoichiometric and cubic pyrochlore phase ($Pb_2Ti_2O_6$, *Fd3m*) was unequivocally identified by XRD and Raman spectroscopy up to approx. 450 ºC. Only tetragonal $PbTiO_3$ was identified at higher temperatures. XAS spectra showed that the local structure around the absorbing Ti atom of the intermediate pyrochlore phase is similar to that observed in the amorphous precursor. This fact indicated that the metastable intermediate pyrochlore ($Pb_2Ti_2O_6$) is kinetically favored to form because of its similarity to the amorphous precipitate, instead of the slightly different and thermodynamically favored tetragonal ($PbTiO_3$, *P4/mmm*) perovskite structure that is only formed at higher temperatures, after the crystallization of the metastable intermediate pyrochlore. In this research field, we start collaboration with Prof. Kakihana, from Tokyo Institute of Technology.

The results of this research were submitted to the J. Sol. State Chem. and are under analysis.

In this period we keep the development of the nanocomposite, focusing the development of new matrix, such as Al_2O_3, TiO_2 MgO and CeO, keeping the Ni as disperse metal nanocrystals. In this development we use similar synthesis approach, i.e., the polymeric precursor method. The results of this research will be published in the J. Nanoscience and nanotechnology as well as in several others magazines (see publication list).

2.2 Semiconductors and Ferroelectric Materials

In this third period, the research in thin films showed very good results, in special the development of $Pb_{1-x}Ca_xTiO_3$ thin films by solution deposition, with very high dielectric constant. We reported dielectric constant around 2000 for a textured film, growth over a $LaNiO_3$ textured layer, growth in a $LaAlO_3$ (100) substrate. The $LaNiO_3$ layer was also growth by chemical solution deposition, and the crystallization process was performed in a microwave furnace, under directional heat flow. A paper containing the results of this research was submitted to the Appl. Phys. Letter and was approved for publication. The crystallization of the film in microwave furnace was patented.

Other important results obtained in the thin film research area was the development of artificial control of the morphotropic phase boundary in heterolayered $Pb(Zr,Ti)O_3$ thin films grown by a chemical solution route. Heterolayered perovskite materials today constitute a new approach for the creation of novel dielectric and ferroelectric properties. We observed superior dielectric and ferroelectric properties for this heterolayered polycrystalline thin film, suggesting a cooperative interaction between the ferroelectric phases, simulating the morphotropic phase boundary (MPB) of this system. For example, the dielectric constant of the heterolayered thin film was significantly enhanced when compared with that of pure PZT40 and PZT60 thin films. A dielectric constant of 701 at 100 kHz was observed for a stacking periodicity of six layers having a total thickness of 150 nm. The heterolayered film exhibited greater remanent polarization than PZT60 and PZT40 films. The values of remanent polarization were 7.9, 18.5 and 31 ?C/cm^2, respectively, for PZT60, PZT40 and heterolayered thin films Our results also demonstrate that the chemical solution route offers opportunities for tailoring heterolayered structures to obtain specific properties or new materials. These results were submitted to the Nature Materials and are under analysis.

The research in semiconducting based ceramics gave very good results mainly in the varistor properties of these systems. The research was concentrated in the understanding of the effect of dopant on the grain

boundary potential barrier formation, by measuring the interface density of states and depletion layer density of states. The influence of the atmosphere on sintering and on heat treatment of these samples were evaluated, indicating that adsorbed oxygen charged species are the main responsible for the interface charged defects. Studies on the degradation of the non-linear properties of these systems were also carried out and the results indicated that tin oxide based varistor are very resistant against degradation. These results have been published in the Journal of European Ceramic, Materials Chemistry and Physics among others.

2.3 Optical and Electrochromic Materials

In this area, the development of a new class of photoluminescente materials, based on amorphous semiconductor oxide processed by chemical process, is the main focus. In this period, the research was focused in the development of quantum mechanic calculation methodology in order to simulated disordered materials. This methodology is fundamental to explain the origin of the photoluminescence process in amorphous oxide materials. The photoluminescence of ABO_3 (A=Sr,Ba,Pb), has been interpreted by means of first principle calculations, DFT a B3LYP level, using a periodic supercell model. The electronic structures derived from models proposed in this study for both crystalline and asymmetric structures allows to calculated electronic properties that are consistent with experimentally determined optical band gap. Moreover, the foresight of electric levels in asymmetric structure within the energy band gap of crystalline ABO_3 (A=Sr,Ba,Pb), is in accordance with the experimental tails and edges observed in the absorbency spectra of amorphous ABO_3 (A=Sr,Ba,Pb). Then, the localized electronic levels induced in the VB by the symmetry break, coupled to the charge gradient induced in the structure, may be the reason for the apparition of photoluminescence properties of amorphized ABO3 (A=Sr,Ba,Pb). This work will be published in the Phis. Rev. B.

2. 4 Crystal Growth and Non-Crystalline Materials

In the research line Crystal Growth and Non-Crystalline Solids we be able to develop an automatic diameter control system to laser heated pedestal growth technique that permit us to grow single-crystal fibber with diameter fluctuations below 1%. This is very important parameter for development of solid state laser. Other interesting result was to define the importance of the oxygen in the photoexpansion process in special glasses for optical applications.

We start also in the single crystal growth line, research about growth in the solid-state. In this project the main target is convert a polycrystalline matrix in a single crystalline matrix, using a single crystal seed. In our study we are using SnO_2

nanocrystals and SnO_2 nanoribbon as seed. We start recently this project, but preliminary results showed that the SnO_2 nanoparticle growths in the same crystallographic orientation of the substrate (SnO_2 nanoribbon).

2.5 Design, Fabrication and Characterization of Microdevices Based on Magnetic and Superconducting Thin Films

This research field of this area have chanced drastically in this period. The research focus was centered basically in the study of nanostructured materials with super-paramagnetic properties. For example Ni nanoparticles embedded in an amorphous SiO2 matrix were produced by sol-gel like process. The particle size distribution were found to have an average radius of ~3nm, as inferred from TEM and magnetic measurements. The magnetic analysis showed also that the metallic particle are free from an oxide layer. The dynamic magnetic properties of this Nanocomposite was also studied by the frequency dependence of the ac magnetic susceptibility. The main results of this topic was published in the J. Appl. Phys as well as in the Appl. Phys. A. We start also the development of nanocomposite with magnetic properties in the shape of thin film. The preliminary results showed that we are able to reproduce the results obtained for the powder in the thin film configuration.

Other research line considered in this period was in the processing of manganites ceramics as well as grown of single-crystalline fibers from de ceramic powder. The results showed that the processing conditions change the crystal structure and the magnetic behavior of these manganites. Moreover, it was demonstrated the manganite fiber growth with colossal-magnetoresistance properties of this ceramic material. These results were published in the Journal of Physics and Chemistry of Solids and in the APL.

3. Technological Results

The technological results due to interaction among the MCDCM and industries follow the same trend reported in last year. It was possible to reach expressive results in the development of products with high technological value and consequently high aggregated value.

The projects developed with the metallurgical sector, consisted in supply technological support to improve the performance of metallurgical equipment, to study the corrosion mechanisms in refractories used in those equipment and to develop new technologies for refractories used in the lining of blast furnace hearth as well as in the lining of torpedo car.

Researchers of the MCDCM also support the improvement of the quality of ceramic products by means of determining the characteristics of the products being processed by several companies and improving the processing of those products. One example is the development of high performance monolithic refractory based on amorphous silica for application in the lining of the glass furnace crown and walls. This new product helps to improve the quality of glasses being produced.

New products have been developed for several companies by means of technically and economically feasible chemical processes. This effort is exemplified with the projects of technical and scientific cooperation with Companhia Brasileira de Metalurgia e Mineração (CBMM). The nanosized niobium oxide being processed using polymeric precursor method and spray pyrolysis has been used for production of niobium oxide powders.

The most important projects related to the technological section are:

1) Development of industrial process for production of nanoparticles of niobium oxide for application in electronic ceramics, using a clean chemical route. This project is under development with CBMM and consists in obtaining of nanosized niobium oxide powders using an appropriated chemical solution and precipitation at low temperatures.
2) Development of industrial process for production of niobium oxide nanoparticles for application in electronic ceramics using spray pyrolysis. This project is under

development with CBMM and consists in use a chemical solution of niobium to obtain a spray by means of high energy piezoelectric ceramic as well as to precipitate the nanoparticles from the spray by using heating.

3) Study on the processing parameters related to the retention of CO_2 and H_2O in niobates. This project was contracted by CBMM aiming to controll the process reported in the item 2.
4) Development of high voltage ZnO based varistor. This project is under development with DELMAR and the goal is to characterize the raw materials, optimization of the processing conditions and formulation of the varistor composition. It is expected that with the optimization of processing, the company could produce high voltage varistor with homogeneous microstructure and reproducible electrical properties.
5) Development of semiconducting enamel for application in the electric insulators surface. This project contracted by Santana Company was concluded this year and the company is using the enamel for covering the ceramic insulators.
6) Development of high performance monolithic refractory based on amorphous silica for application in the lining of the glass furnace crown and walls. The project contracted by Praxair/FAPESP has been concluded and was object of a Brazilian patent (PI 0302688-4, June 26, 2003). Praxair is willing to transfer this technology for producing these refractories with high resistance against corrosion in those furnaces being heated by oxy-fuel combustion.
7) Development of Solid Electrolytes for oxygen sensors in molten steels. This project is under development and was contracted by a not disclosed company. The main goal is to develop high thermal shock resistance ceramic sensors for oxygen monitoring during fabrication of special steels. The developed sensors show high resistance to thermal shocks at temperatures as high as 1600°C.
8) Development of temperature sensors. This project is under development and was contracted by a not disclosed company. A prototype of a temperature sensor has been developed based on NTC perovskites. The main processing parameters for the reproducible fabrication of the batch quantity of sensors is currently being studied.

9) Improvement of refractory lining of blast furnace heart. This project, contracted by CSN has been concluded. Based on the former project of blast furnace heart it was proposed the improvement of the refractory lining by the chemical deposition of ceria and zirconia on carbon blocks of the Blast Furnace of the company. The objective is to enlarging the heart campaign and also to obtain a process for the recovering carbon blocks of the Blast Furnace Heart.

10) Al_2O_3/SiC/C/$MgAl_2O_4$ refractory lining used in torpedo cars. This project contracted by CSN has been concluded. A post mortem study of the refractory lining was realized with the objective of determining the mechanism of the corrosion developed during the industrial application. It was concluded that slag containing a high amount of calcium aluminum-silicate interacts with the microstructure of the refractory promoting the corrosion.

11) New desulfurization mix for reducing the sulfur content of pig iron. This project contracted by CSN has been concluded. In the current context of the integrated steelworks installed in Brazil, the actual operational practice of the blast furnace aims at improving the desulfurization rate of the pig iron. The objective of this study was to develop at laboratory level, a methodology for the scale simulation of the pig iron desulfurization process. The result of this study could reduce the cost for the development and formulation of new desulfurization mixes.

12) Evaluation of the refractory lining of the ignition furnace of the sinter plant of CSN. The project contracted by CSN has been concluded. The objective of the project was to evaluate the refractory linings of the CSN ignition furnace of the sinter plant. The degradation of the refractory was studied in laboratory scale to contribute for the selection of new refractories, displaying a better performance at the operational conditions. Procedures for preventive refractory maintenance, with the goal of prolonging the campaign of the equipment was also considered.

13) Enhanced behavior of the torpedo car refractory by the nanoparticulate cerium impregnation technique. This project was contracted by CSN and is under development. A cerium solution was developed to occupy the free pores in the microstructure of the torpedo car refractory lining aiming the enhancement of the

corrosion resistance. It was observed that the nanoscale protection mechanism introduced by the use of nanoparticulate cerium impregnation technique. After the dynamic slag and fracture energy tests, it was verified that this new corrosion prevention technique decreased to 8% the damages in the torpedo car refractory lining.

14) Influence of the product composition and operational parameters on the Taphole mix operational performance. This project was contracted by CSN and is under development. The objective is to study the behavior of different taphole mixes under critical operational conditions, in order to optimize the performance of commercial products. This study involved laboratory simulations and post mortem studies of different taphole mixes used. It is expected that the results of this study will minimize the time maintenance, reduce costs and improve the performance.

15) Study of the behavior of the Al_2O_3–Cr_2O_3 and Al_2O_3-ZrO_2 refractory systems, working in close contact with molten glasses for the production of biocompatible ceramic fibers. This study was contracted by RCR Corporation and is under development. The main objective is to verify the influence of the impurities come from the refractory lining during the production of biocompatible glasses (or fibers).

16) Development of a process for the cleaning of foundry sands. This project was contracted by MARCHESAN S/A, an aggricultural instruments industry. This plant works with a foundry porocess generating large amounts of residues of phenolic resin impregnated sands which are verry harmifull for the environment. It was developed an efficient cleaning system with low energy consumption.

17) Development of translucent alumina pieces for dentistry applications. This project was contracted by Tecnident Ltda, of the dendistry sector aiming to produce translucent alumina bracts.

18) Chemical/Ceramic Synthesis/Inovatio The group devoted efforts to the development of a new class of ceramic powders defloculant based on pre-polymeric chemicals and managed to do so. A patent manuscript has been submitted for FAPESP appreciation and sponsorship.

19) The group developed an special Al_2TiO_5 composition chemically stable and resistant to aluminum melts which was produced by CHR Cerâmica Técnica of São Carlos and tested in big Brazilian Aluminum companies with total success. The project was financed by CHR- Cerâmica Técnica São carlos. From this work a paper was published in conjunction with the company CHR- Cerâmica Técnica. Efecto de la estequiometria y de la temperatura de coción el el desarrollo de la fase Al_2TiO_5 – Fonseca, A. P. A., y Baldo, J. B. – Boletín de La Sociedad Española de Cerámica y Vidrio - 42 – 2 – 65-68 – 2003.
20) Engineering & Craftsmanship. The group managed to develop, using indigenous Brazilian materials, a new(no similar) precise digital friendly version of the Gallenkamp torsion viscosimeter, of low cost. Tests were made at the central laboratories of the Roca Group in Jundiaí SP with total success. ROCA Group is investing.
21) The group devised a new testing method for pure shear evaluation of concrete specimens, devoted to evaluate the effect of fiber reinforcement on shear of Portland concrete, specially for keyed structures in bridges.
22) The group has developed a new aluminum silicate (fireclay class) refractory composition for the Company Refratário Scandelari, using cheaper raw materials mined near the company head quarters, in substitution of a special flint clay which was mined 500km away from the company.
23) The group is working along with ELFUSA Gerla de Eletrofusão in the development of new electrofused refractory aggregates for cement kilns refractory linings. A special $CaTiO_5$ electrofused aggregate has been developed and early tests indicate a very promising material.
24) Recycling of Ceramic Industry Waste. The group has proved that it is possible to recycle virgin (despite un-appropriate to sell) scrap from the brick, floor and roof tile and sanitary ware industry, as a substitute for the normal coarse aggregate and sand in non structural concrete and mortars for laying and masonry purposes. Two IC students of the group were awarded two best papers awards during the International Scientific Initiation Congress sponsored by the University of São Paulo

Campus of São Carlos in november 2002. Several industries in the area of Civil Engineering are negociating the project in this tema.

25) Ceramic processing of graphite. This project was contracted by Faber Castell and is under development. The project consists in adjustment of processing of the graphite aiming to obtain graphite with higher mechanical resistance by using the injection molding and nanoestructured dopants. This project resulted the patent 4 described in this report.

4. CONTINUOUS EDUCATION AND DISSEMINATION DIVISION:

Introduction
We have advanced in our activities of continuous education and dissemination with the general objective to introduce basic concepts of ceramic materials, physics and chemistry for students of elementary up to high school levels. In all classroom activities we defined together with the teachers the details about the concepts to be explored in materials science.
Our Activities can be presented as:

1. A trip to the ceramic world - Researchers from the MCDCM have tripped to different schools to present the general concepts and features of the ceramic materials. In special two cities were visited: Monte Aprazível city and Promissão city located in the northeast region of the São Paulo state (approximately 300 Km from MCDCM). It was *for the first time* that researchers from the university visited both schools to introduce new concepts to the students. Special attention was dedicated to explain the difference between glass, crystal and traditional and advanced ceramics. Several experiments were showed in order to introduce basic concepts associated with chemical reaction, fluids, magnetic and electrical phenomena and optics. A total of 300 students participated of these activities. It was possible also to speak about the importance to complete their studies and to make them think about interesting and exciting themes in science.

2. Teaching Physics Through Experiments - In 1826, physicist Michael Faraday founded the Children's Christmas Lectures at London's Royal Institution. His goal was to communicate the children the excitement of scientific discovery. In keeping with the spirit of those lectures, MCDCM members performed at Institute of Physics of São Carlos, physics demonstration and lectures for high school students as part of last past year continuous education and dissemination program. This new approach was called the project "*A Escola no Centro Cerâmico*" (*The School in the MCDCM*), where students from high schools of cities in the northeast region of São Paulo state spend one morning talking and discussing science. All those activities has two major objectives: the first one is to teach the basic concepts of science with a different point of view and where those concepts are applied in the day-by-day situations. The second one is to show those students (potential future graduate students) and teachers the ambient of the university life and to try to create the questioning and thinking behavior about several issues, and not just believe in what the teachers tell them. This is done through the scientific curiosity, and in this way, we strongly believe that this can make an important contribution to the preparation of those students for the reality that they will face in their future professional lives.

3. Students at the MCDCM labs - As an extension of the earlier projects, we introduce a new approach on the teaching the concepts of chemical and physical process involved in the ceramic properties and production process. This project consists in transform the high school senior students from nearby cities in graduation students for one day. The students have the opportunity to live as real graduate students, with a visit to the Universidade de São Paulo and university ambient and MCDCM laboratory activities. The visit starts with a lecture about the Universidade de São Paulo Campus, and after this lecture the high school students are invited to visit the several units of the campus, including its infrastructure (restaurants, sports center, etc..). The following activity is the lunch time, where everyone eats at the university restaurant. During this lunch time the high school students have the opportunity to talk with the actual graduate students about the course they are interested and its characteristics. In the afternoon the students are separated into groups of 3-5 people and they visit the researches laboratory of MCDCM. In this part of the day they are treated as real researches and some simple laboratory problems and tasks are presented to the group and they are asked to solve them. They must work as a team and they actually feel the need of the rationalizing about the problem, and how important is the basic knowledge in physic and chemistry.

4. Ceramic Materials Educational Project - Another approach used by the MCDCM was the *PEMCe project* (explained in datailed in our last report) for the training of teachers and students through classes given by the members of the MCDCM in public schools (specially the ones with low economical resources). Last year the school chosen for this activity was "André Donatoni" from Ibaté city. Science and technological themes as thin films, wave guides and optical fibers, colors and light, glasses, electronic and artistic ceramics were organized in several 50 minutes lectures (with experimental apparatus). The 310 students from 5th to 8th grades participated on this event, that occurred in their classroom with different researchers every 50 min, during one whole week. After this encounter, the students were asked to write an assay about the topic "Ceramics Materials". This assays were then analyzed by MDCDM members and by the teachers at the school. Those texts helped us, as a qualitative measure, to verify the efficacy of the method applied. The results shows us that the students could absorb great amount of information and that they could retain it for long periods of time (meaning that the information was brought together with the formation of the students). As described in our first report, the MCDCM members that applied this project felt as happy and motivated as the students.

5. International School on Crystal Growth and Advanced Materials

The objective of the International School on Crystal Growth and Advanced Materials (ISCGChA) is to foster activities connected with the growth and characterization of crystals, with particular emphasis on training, scientific research and technological applications. The idea is that researchers in this field from all over the world will be able to meet and learn from each other. The ISCGChA also promoted the training and development of young students and researchers. Themes in principles and methods of crystal growth were presented together with different characterization techniques. The ISCGChA was a forum for discussion of aspects of crystal growth, the challenges we face at the present time, and perspectives for the future.

6. Course on Nanotechnology for Undergraduate Students

MCDCM has structured and developed the Course on Nanoparticles and Nanostructures held in January at UFSCar. In this course were given classes with the objective of offering to the students a comprehensive vision of Nanotechnology and its implications for the economic and industrial development, as well as the basic concepts that guide its development. The students of Chemistry that have participated of this course came from USP (São Paulo, Ribeirão Preto and Bauru), UNESP (Araraquara and Bauru), UNICAMP (Campinas) and UFSCar (São Carlos). There was an extensive discussion between the teachers, the students and the coordinators of the course aiming at flexibilizing the curricula and allowing the improvement of the professional formation directed to the working market. On the other hand, the students had the opportunity to know the research activities of MCDCM in this area by means of the analyses of the papers published in the last two years.

7. The Ceramic Center Hosts High School Teachers and Students

In this period were scheduled visits to the Ceramic Center of high school teachers and students. The visits were held at the Group of Crystal Growth and Ceramic Materials – USP and at the Interdisciplinary Laboratory of Electrochemistry and Ceramics of the Department of Chemistry of UFSCar. These students, during a 8 hour period received explanations and participated of mini-analyses in several pieces of equipment: X-ray diffractometer, scanning electron microscope, atomic force microscope and tunneling microscope. They were also given a short lecture on Molecular Modeling using the first principles of Quantum Mechanics. The four modules were taught in practical classes of 100 minutes. These courses are opened the whole year, only needing that the high school is registered at USP or in LIEC-UFSCar.

The visit of high school teachers and students to the research laboratories of the universities deserved a special projection in the American review Journal of Chemical Education.

According to the editorial, teachers of Science, Physics, Chemistry and Biology high a higher amount of information are able to gather important information for their students. The activities undertaken by the Ceramic Center were shown to be perfectly aligned with such tendency of high school students getting in touch with laboratories during scheduled visits. Therefore there is a team in the center available to organize and carry out such diffusion work. High schools from the cities of São Carlos, Promissão and Matão have visited the Center.

8. Production of the Craftsman Handout

The Ceramic Center undertake in 2001, in a partnership with Comunidade Solidária visits to six Brazilian states diffusing theoretically and experimentally the technology of ceramic processing. This linkage to craftsman of small poor communities was spread out to craftsman located at medium and big cities in the 2002/2003 period. Besides offering free advising to these craftsmen, the Ceramic Center has remodeled completely the **handout** "Cerâmica – a Técnica por Trás da Arte" ("Ceramics – the Technique behind the Art"), which was edited and distributed to the communities of ten Brazilian states.

The Center owns nowadays a data center controlled by Dr. C. A. Paskocimas, which guides the craftsman in the acquisition of raw materials and offers an optimized formulation and the most favorable conditions of drying and sintering of the ceramic pieces.

9. Production of Educational Video

In order to make more dynamic the learning process and offering a more concrete vision of the production of ceramic pieces by the **slip casting process**, a video was elaborated tackling all the processing phases: from the formulation up to the sintering. Parallelly to the video in the high schools is shown in the practice the process of using **barbotina** for the molding of ceramic pieces. Following, for the students and teachers present are given speeches stating the details of this production process of ceramic and semi-artisanal pieces. This didactic material was distributed in the high schools after the speeches, guaranteeing future discussions about this subject. It should be emphasized that in all the high schools visited the principals and the teachers demonstrated to be highly interested in the next productions of the Ceramic Center related to the different ceramic processes.

10. Production of 3D Animation

The Ceramic Center started very timidly in 2001 the production of animations at the 3D level. In this period were elaborated twelve 3D animations (films during 2 or 3 minutes). They were exhibited in the high schools and during paper presentations in Brazil and abroad. The basic objective of the animations is to show in a clear and scientific way the development of the research activities of the Center, moreover in nanostructure, nanoparticles and catalysis. On the other hand, there has been a great interest from the regional TV stations to show the animations associated with the research activities undertaken by the Center, what resulted in an average of one monthly interview in TV channel of highest audience in the region. Nowadays this way of diffusion has already guaranteed a space in the national media in closed TV channels. It should be emphasized that this year (October) the Academy of Machinima Arts and Sciences Festival showed an intense participation of 3D animation films in New York. This fact demonstrates the importance in the future for the diffusion of science in all the levels.

11. Ph. D. Linked to the Industrial Sector

In this period the Ceramic Center has looked for, besides increasing the interaction with the industrial sector, to foster with the innovation system the engagement of students in taking the Ph. D. In a partnership with Companhia Siderúrgica Nacional (CSN), John Faber and Saint Gobain, companies related to steel, pencils and glass, respectively**,** are being investigated technical-scientific themes with the objective of innovating, improving the human resources in the industry. These three Ph. D. courses have already yielded patents, financed by the producing sector. Therefore, there is the concern from the Center in diffusing the knowledge at all the levels, chiefly by decreasing the gap between University and Industry, creating in this way interlocutors for the usage of knowledge in a more objective way.

12. Diffusion of the Ceramic Center in Congresses and Fairs

The Center organized a panel with its main activities, stressing: a) Nanotechnology. b) Electronic Ceramics. c) Structural Ceramics. d) Artistic Ceramics. In three opportunities the activities were disclosed to the public by means of the aforementioned panel.

1) II Hall of the Forum of Technological Innovation and Technologies Applied in the Production Chain – Brasiltec, from July 29 to August 2,2003, held at the Exposition Pavilion in Center Norte, São Paulo. This event received the visit of 200,000 people, including industrial managers, researchers, and high school teachers and students.
2) Brazilian Ceramic Congress, held at João Pessoa, Paraíba state in the period from June 14 to June 18, 2003, counting with 620 participants of the Congress.
3) Brazilian Congress in Materials Science, held at Natal, Rio Grande do Norte state in the period from November 9 to November 13, 2002, counting with1680 participants of the Congress.

13. Artistic Ceramics: An Interdisciplinary Theme in a Continuous Education Course

The Ceramic Center, in partnership with the São Paulo State Secretariat of Education, Local Section, has promoted a Continuous Education Course for teachers of Chemistry, Physics, History, Arts and Geography from high school teaching of the region. With the goals of presenting to the teachers theoretical pedagogical instruments, accomplish a professional up dating and facilitate the integration of the teachers to the Ceramic Center, the course had and its main theme Artistic Ceramic.

The choice was owing to the proved existence of a coherence between the theme and the political, ethic and aesthetic values that inspired the Brazilian Constitution and the law of "Diretrizes e Bases" (Guidelines and Bases for Education), organized under three consignas: sensibility and social-economic.

An important feature of this 40-hour course for 40 teachers was that it supplied the teachers tools and information in order for them to own the theme and could, thus, more easily explore the interdisciplinary aspects with the students.

14. Extension Course for Teachers

A great amount of knowledge with a lot of practical work in the classroom, this was the conclusion of the high school teachers that participated of the Extension Course for Teachers. In this course were offered notions of fundamental chemistry from a series of practical experiments, involving also video and 3D animation. The participation of 70 teachers in the course has showed the great interest of the teachers in getting up to date in order to make more dynamic their classes. On the other hand, each participant received a set of 30 Craftsman **Handouts,** which were employed in the teaching for the students in the ceramic art and in the connections with chemistry and physics, associated with materials. This program incorporated around 14000 high school students in São Paulo metropolitan region. In a second step, the teachers will visit São Carlos, in order to know the modern techniques of materials characterization, organized in 16 teacher-groups.

15. One Day of Undergraduate Student
Forty five students of Colégio Dom Bosco, a high school from Monte Aprazível city, in the region of São José do Rio Preto, were hosted to be undergraduate students for one day at the Ceramic Center.
As newly come students to the University, the freshmen had a welcome speech at the Institute of Physics – USP – São Carlos. At this opportunity the students attended classes , had launch at the University Cafeteria and got in touch with the undergraduate and graduate students, as well as with the university teachers.

16. Participation of the Center in National and International Reviews
a) The Ceramic Center, by means of Prof. Dr. Reginaldo Muccillo selects and edits the Revista Cerâmica, official organism of the Brazilian Ceramic Society. Prof. Dr. J. A. Varela and Prof. Dr. E. Longo, other members of the Center are also members of the editorial committee of Revista Cerâmica.
b) The Center has also a strong participation in the review Revista Cerâmica Informação, edited by Faenza Editrice do Brasil Ltda. Prof. Dr. J.O. Paschoal, a member of the Center is the Technical – Scientific Editor of the review and Prof. Dr. E. Longo is also one of the members of the technical – scientific council of the review.

17. Diffusion in Newspapers, Radio and TV
Last, but no least, it is important to comment the interface of MCDCM with the media. In this period, information about Ceramic Materials was disseminated by means of the written press, radio and TV.
Newspapers from São Carlos (Primeira Página and Tribuna) and Araraquara (Imparcial) covered news about MCDCM achievements in the Innovation Projects, emphasizing the development of materials made in partnership with CSN, White Martins (PRAXAIR), CBMM, and Faber-Castell. O ESTADO DE SÃO PAULO, a newspaper of undoubtfully national coverage, also covered the achievements of MCDCM emphasizing also the advantages that the industrial partners of MCDCM are having with such a fruitful partnership.
The technical developments obtained on Materials (photoluminescence, nanoparticles, and nanostructure) benefited the whole region, showing clearly the multiplying role of the University-Company interaction. As a consequence, EPTV, the TV Company covering the whole Central Region of São Paulo state, produced as series of reports covering the activities of MCDCM and TV-Cabo Branco of the Paraíba and TV Ponta Negra of the Rio Grande do Norte.

18. Ceramic Bulletin (Informativo Cerâmico – ICeram) - We have continued with the edition of the Ceramic Bulletin with the unique objective to give information of our activities in education and science dissemination. In this period we published 3 issues of the Ceramic Bulletin and a total of 3000 copies were distributed for all students free of charge.

19. 3rd Meeting of the Ceramic Materials Center - MCDCM – In this 3rd Meeting the members of the MCDCM presented their results in research, education and innovation.

Concluding remarks of the continuous education activities

In this period (2002-1003) several activities in the continuous education program were developed. These activities were opened to elementary and high school students with the main purpose to open their mind to understood science and their technological aspects. A broad subject was covered in this program correlating the concepts of ceramics with chemistry and physics. The program a "trip to the ceramic world" was a successful presentation for 300 high school students in two cities. Another project motivated the students for physics and chemistry problems and enrolled other 1000 students and 15 teachers in our macro region. These educational projects were extended to two elementary schools in São Carlos. During a summer school a course of nanotechnology applied to ceramic materials was offered by MCDCM members. Several undergraduate students from UFSCar, USP, UNESP and UNICAMP participated of this course. Other events such as the International School on Crystal Growth and Advanced Materials were realized being the MCDM one of main organizer of this event.

In order to make more dynamic the learning process the group produced education videos about ceramic processes. The production of 3D animations reach a good quality films that are exhibited in the high schools and in diffusion programs of the regional TV centers.

A special program of the MCDCM has motivated the craftsman to learn about the processing the ceramic materials. A special material was edited by the MCDCM with the sponsorship of Centro Cerâmico do Brasil which was distributed to their associates.