CMDMC

MULTIDISCIPLINARY CENTER FOR THE DEVELOPMENT OF CERAMIC MATERIALS

REPORT 1

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

PERIOD FROM OCTOBER 2000 TO SEPTEMBER 2001

SEPTEMBER 29, 2001

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REPORT (1) – MCDCM

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1. Overview

The advances in research projects, technological transfer projects and the main educational activities achieved in this center are reported for the first year of this project. As described in this report, in this first year the advances in the research projects can be considered excellent, since the productivity of the majority of the groups related to the center has been substantially improved. This is an important major result of the center, since the collaborations of different groups resulted in improved productivity of individuals. The key strategy in this first year was the interaction within the center and outside the center. That interaction resulted in 133 papers published in international (120) and national magazines (13). Considering the several sectors of the Research Division, the number of papers per sectors was: Chemical Synthesis = 12 ; Semiconductors and Ferroelectric Materials = 83 ; Optical and Electrochromic Materials = 5 ; Crystal Growth and Non-Crystalline Materials= 14 and Design, Fabrication and Characterization of Microdevices Based on Magnetic and Superconducting Thin Films = 19 . Figure 1 shows the relative productivity per sector .

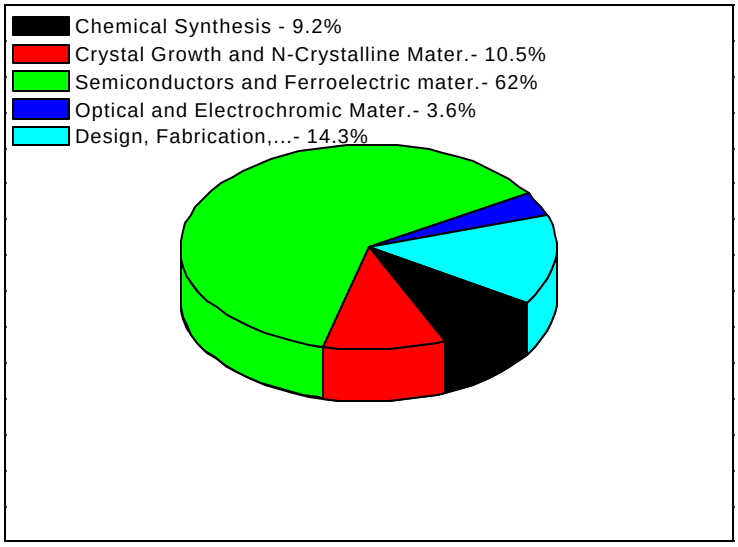

Figure 1 – Relative production for the first year (200-2001)

One of the main qualities of the center is its ability to transfer the knowledge developed in several research projects to the industries by means of joint technological research programs. In this area, the results in this first year were also very significant. The number and quality of these projects encompassing several research areas are quite large, compared with the overall projects developed in the past year. Then, the environment and the management of the center are the keys for these achievements. Several projects were

conducted with companies like CSN, CBMM, White Martins/Praxair and Isoladores Santana, leading to outstanding results (including 7 patents) and several awards given for their technical contents. Other indicative of the strong interaction with the industrial sector is the number of papers published with the technical staff of the different companies with which we have interaction. A total of 10 papers were published, including the paper published in the Iron & Steelmaker magazine in which our paper was the main article of that issue (Figure 2 shows the cover of the magazine). All these projects were well related to research areas of the group as individually described bellow. For example, the project with CBMM is related to the development of Nb_2O_5 nanoparticle using niobium citrate as precursor. This project is a direct application of the Pechini process to solve an industrial problem. Other example is the development of a semiconductor enamel for electrical porcelain. In this project, we are using Sb-doped SnO_2. Let us emphasize that SnO_2 is one of the most important materials in our basic research program.

Certainly, the greatest challenge for our center is the diffusion of the knowledge developed in our center to the society, and especially to different levels of education. In this sense, in this first year we were able to develop a brochure for the poorly educated craftsmen that use ceramics to express their art. Subsequently to this brochure, we established several short courses in very low-income regions where the poverty is the main issue. Other kind of diffusion was established in our region by means of lectures, given by several members of the center, in elementary and high schools, about several subjects related to the chemistry of materials. Considering the undergraduate and graduate levels, the Center gave total support to the 6th Winter School of Physico-Chemistry and Analytical Chemistry. The Center organized this event and their members presented lectures and were responsible by short courses.

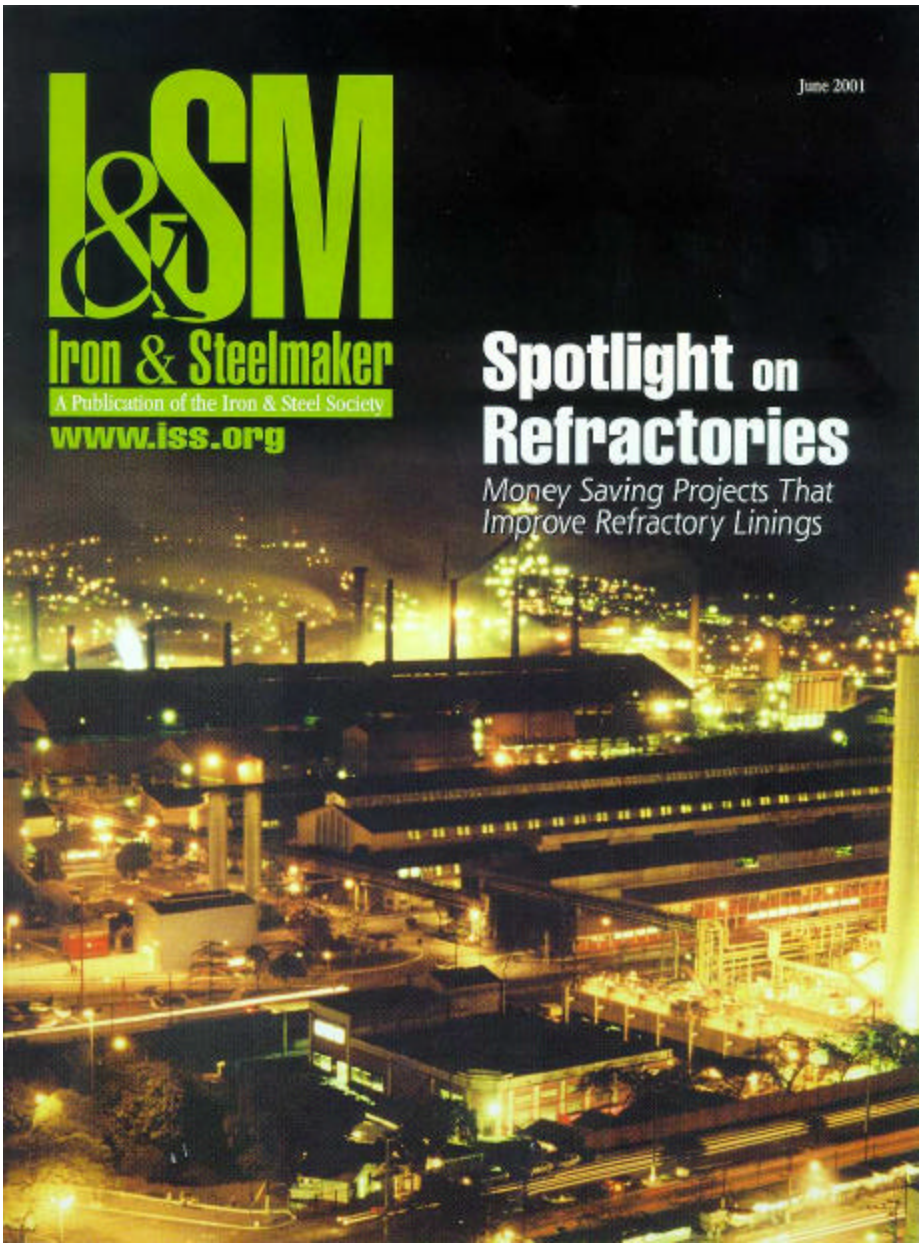

Figure 2 - Cover of the Iron & Steelmaker magazine in which our paper was the main article of that issue

1.2 – Team List

PRINCIPAL INVESTIGATORS

Name	Institution	Position/Responsibility
E. Longo	UFSCar	Center Director
J.A. Varela	UNESP	Innovation Division
D.R. Hartwig	UFSCar	Continuous Education for Teachers
L.O.S. Bulhões J.B. Baldo	UFSCar UFSCar	Eletrochromic and Optical Materials Refractories and Corrosion
W.A. Ortiz	UFSCar	Superconductors and Magnetic Materials
E.R. Leite	UFSCar	Ferroelectric Thin Films and Chemical Synthesis
A.J.A. Oliveira	UFSCar	Magnetic Materials
A.C. Hernandes	USP - São Carlos	Crystal Growth and Non-Crystalline Materials and Dissemination
C.A. Paskocimas	UNESP	Ceramic Pigments
M. Cilense	UNESP	Semiconductors and Ferroeletric Materials and Electroceramic Devices
J.O.A. Paschoal	IPEN	Continuous Education for Workers and Ceramic Tiles
R. Muccillo	IPEN	Intragranular phenomena in Ceramics Oxides Technology: Development of Ceramic Sensors
J.B. Baldo	UFSCar	Coordinator – Refractors Laboratory
M.A. Zaghete	UNESP	Powder Synthesis

SENIOR INVESTIGATIORS

NAME	Institution	SUBPROJECT
E.N.S. Muccillo	IPEN	Intragranular phenomena in Ceramics Oxides Technology: Development of Ceramic Sensors
W. Libardi	UFSCar/DEMa	Vice Coordinator - Refractors Laboratory
L. A. PERAZOLLI	UNESP	Semiconductors
B. Stojanovic	UNESP	Ferroelectric Materials
W.C. Las	UNESP	Semiconductors

JUNIORS INVESTIGATORS

NAME	Institution	Supervisor
F.N M.L. PONTES	UFSCar	E. Longo
V. C. SOUZA	UFSCar/LIEC	E. Longo
A. P. F. ALBERS	UFSCar/LIEC	E. Longo
F.O . C. D. LEMOS	UFSCar/LIEC	E. Longo
W. A. C. PASSOS	UFSCar/GSM	W.A. Ortiz
E. P. R. PADILLA	UFSCar/GSM	W.A. Ortiz
C. A. O. AVELLANEDA	UFSCar/LIEC	L.O.S. Bulhões
H. . L.M. VILLULLAS	UFSCar/LIEC	Luis O.S.Bulhões
F. I. M.-COSTA	UFSCar/LIEC	Luís O. S. Bulhões
M.C. SANTOS	UFSCar/LIEC	Luís O. S. Bulhões
P. N. M. ANJOS	UFSCar/LIEC	E.C.Pereira
P. N. LISBOA FILHO	UFSCar/LIEC	E. R. Leite
S. M. ZANETTI	UNESP	J.A. Varela
Z.BRANCOVIC	UNESP	J.A. Varela
S. CARTREEDGE	UNESP	J.A. Varela

PhD, MsC AND UNDERGRADUATED STUDENTS FORMED IN THE FIRST YEAR

NAME	Institution	Advisor	Date	Level
L.G. VIEIRA	UFSCar/LIEC	E. Longo	08/2000	PhD
J. H.G. RANGEL	UFSCar/LIEC	J.A. Varela	07/2001	PhD
F. M. L. PONTES	UFSCar/LIEC	E. Longo	08/2001	PhD
S. M. ZANETTI	UFSCar/LIEC	E.R. Leite	02/2001	PhD
F. R. SENSATO	UFSCar/LIEC	E. Longo	03/2001	PhD
J. BARBOSA	UNESP	M. Cilense	04/2001	PhD
T.MAZON	UNESP	M.A. Zaghete	09/2001	PhD
J.C. CARVALHO	UNESP	J.A. Varela	07/2000	PhD
S. M. TEBCHERANI	UNESP	J.A. Varela	07/2001	PhD
P. N. LISBOA FILHO	UFSCar/GSM	W.A. Ortiz	03/2000	PhD
C. C. FARIA	UFSCar/GSM	W.A. Ortiz	08/2001	PhD
W.A. C. PASSOS	UFSCar/GSM	W.A. Ortiz	05/2001	PhD
R. C. FARIA	UFSCar/LIEC	L.O.S. Bulhões	02/08/00	PhD
C. A. LINDINO	UFSCar/LIEC	L.O.S. Bulhões	03/2001	PhD
E. I. SANTIAGO	UFSCar/LIEC	L.O. S. Bulhões	03/2001	PhD
E. C. PARIS	UFSCar/LIEC	E. Longo	11/2000	MsC
V. L.PARSEKIAN	UFSCar/LIEC	E. Longo	11/2000	MsC
A. ZENATTI	UFSCar/LIEC	E. Longo	25/05/01	MsC
A.A H. M. GONZÁLEZ	UNESP	J.A. Varela	03/2001	MsC
R. GIMENES	UNESP	J.A. Varela	07/2001	MsC
G. P.CASALI	UFSCar/LIEC	E. Longo	06/2001	MsC
F. C. FONSECA	IPEN	R. Muccillo	05/2001	MsC
S. K. TADOKORO	IPEN	E. N. S. Muccillo	09/2000	MsC
V. C. GELFUSO	UFSCar/GSM	W.A. Ortiz	05/2001	MsC
R. CAPARROZ	USP/GSM	W.A. Ortiz	04/2001	MsC
J. VARALDA	UFSCar/GSM	A.J.A. Oliveira	09/2001	MsC
L. E. T. FELICIANO	UFSCar/LIEC	E. C. Pereira	03/2001	MsC
M. L. CARDOSO	UFSCar/GSM	A.J.A. Oliveira	06/2001	MsC
U.R. OLIVEIRA	UFSCar/GSM	W.A. Ortiz	12/2000	Undergraduated
P. C. VENTURINI	UFSCar/GSM	W.A. Ortiz	12/2000	Undergraduated
A. YOSHIDA	UFSCar/GSM	W.A. Ortiz	07/2001	Undergraduated
U. COLETO JÚNIOR	UNESP	L.A. Perazolli	07/2001	Undergraduated
T.R. GIRALDI	UNESP	L.A. Perazolli	03/2001	Undergraduated
G. A. P. RIBEIRO	UFSCar/GSM	A.J.A. Oliveira	12/2000	Undergraduated
S. S. ALMEIDA	IPEN	E.N. S. Muccillo	03/2001	Undergraduated

PhD STUDENTS

NAME	Institution	Advisor
L.E. B. SOLEDADE	UFSCar/LIEC	E. Longo
F. R. SENSATO	UFSCar/LIEC	E. Longo
V. F.MONTEIRO	UFSCar/LIEC	E. Longo
G. P. CASALI	UFSCar/LIEC	E. Longo
C. D. PINHEIRO	UFSCar/LIEC	E. Longo
M. S. C. CÂMARA	UFSCar/LIEC	E. Longo
M. I. B. BERNARDI	UFSCar/LIEC	E. Longo
W. K. BACELAR JR.	UFSCar/LIEC	E. Longo
S.M. JUSTUS	UFSCar/LIEC	E. Longo
S.K. TADOKORO	IPEN	E. N. S. Muccillo
N. H. SAITO	IPEN	E. N. S. Muccillo
D. Z. FLORIO	IPEN	R. Muccillo
F. C. FONSECA	IPEN	R. Muccillo
W. LACERDA JÚNIOR.	UNESP	W.C. Las
M. S. SILVA	UNESP	M. Cilense
P. D. SPAGNOL	UNESP	J.A. Varela
A. DIBB	UNESP	J.A. Varela
F. VERNILLI	UNESP	J.A. Varela
G. BRANKOVIC	UNESP	J.A. Varela
A. H. M.GONZÁLEZ	UNESP	J.A. Varela
A. A. CAVALHEIRO	UNESP	M.A. Zaghete
A. Z. SIMÕES	UNESP	M.A. Zaghete
R.CAPARROZ	UFSCar/GSM	W.A. Ortiz
J. VARALDA	UFSCar/GSM	A.J. A. Oliveira
P.E. N. SOUZA	UFSCar/GSM	A. J. A. Oliveira
M. L. CARDOSO	UFSCar/GSM	A.J.A. Oliveira
M. R. G. OLIVEIRA	UFSCar/DEME	D.R. Hartwig
S. R. ZULIANI	UFSCar/DEME	D.R. Hartwig
R. T. S. OLIVEIRA JR.	UFSCar/LIEC	E. C. P. Souza
J. T.MATSUSHIMA	UFSCar/LIEC	E.C. P. Souza
D. X. SILVA	UFSCar/LIEC	E. C. P. Souza
L.E. T. FELICIANO	UFSCar/LIEC	E. C. P. Souza
A. V. ROSÁRIO	UFSCar/LIEC	E. C. P. Souza
A. J. TEREZO	UFSCar/LIEC	E. C. P. Souza
A. A. CORREA	UFSCar/LIEC	E. C. P. Souza
I.N.TOMITA	UFSCar/LIEC	L.O.S. Bulhões
A. MANZOLI	UFSCar/LIEC	L.O.S. Bulhões
P. R. BUENO	UFSCar/LIEC	L.O. S. Bulhões
V. VELANI	UFSCar/LIEC	L.O. S. Bulhões
M R. C. SANTOS	UFSCar/LIEC	J.A. Varela
S. S. CAVA	UFSCar/LIEC	J.A. Varela
J. H. G. RANGEL	UFSCar/LIEC	J.A. Varela
M. M. OLIVEIRA	UFSCar/LIEC	J.A. Varela
E. C. PARIS	UFSCar/LIEC	E. R.Leite
A. PEREIRA MACIEL	UFSCar/LIEC	E. R.Leite
N.L.V. CARREÑO	UFSCar/LIEC	E. R.Leite
I. T. WEBER	UFSCar/LIEC	E. R. Leite
M.R.B. ANDREETA	IFSC/USP	A.C. Hernandes
A.L. MARTINEZ	IFSC/USP	A.C. Hernandes

C.R. FERRARI	IFSC/USP	A.C. Hernandes
Z.S. MACEDO	IFSC/USP	A.C. Hernandes
E.R.M. ANDREETA	IFSC/USP	A.C. Hernandes
P.P. NEVES	IFSC/USP	Valmor R. Mastelaro
C.A.C. FEITOSA	IFSC/USP	Valmor R. M astelaro

MsC students

NAME	**Institution**	**Advisor**
C. VILA	UFSCar/LIEC	E. Longo
M. ZAMPIERI	UFSCar/LIEC	E. Longo
R. C. R. FRANCO	UFSCar/LIEC	E. Longo
M.O. ORLANDI	UFSCar/LIEC	E. Longo
A. ZENATTI	UFSCar/LIEC	E. Longo
S.R. LÁZARO	UFSCar/LIEC	E. Longo
S. K. TADOKORO	IPEN	E.N.S. Muccillo
F. LEITÃO	IPEN	E.N.S. Muccillo
R. A. ROCHA	IPEN	E.N.S. Muccillo
J.F.Q. REY	IPEN	R. Muccillo
E.CAPRONI	IPEN	R. Muccillo
J. E.LAMAS	UNESP	M. Cilense
D. R. LEITE	UNESP	W.C. Las
G.GASPAROTTO	UNESP	M. A. Zaghete
L. C.R . ALIAGA	UFSCar/GSM	W.A. Ortiz
L. M. OLIVEIRA	UFSCar/GSM	A.J.A. Oliveira
G. A. P. RIBEIRO	UFSCar/GSM	A. J.A. Oliveira
J. B. FREITAS	UFSCar/DEME	D.R. Hartwig
E. T. O. NASCIMENTO	UNESP	L.A. Perazolli
F. P. ALMEIDA	UNESP	L.A. Perazolli
T.B. P.L. SOUZA	LIEC/UFSCar	E. C. P. Souza
F. T. STRIXINO	UFSCar/LIEC	E. C. P. Souza
E. K. KAIBARA	UFSCar/LIEC	L.O.S.Bulhões
L. F. M.VALVERDE	UFSCar/LIEC	L.O.S. Bulhões
R. M. V. LIMA	UFSCar/LIEC	L.O.S. Bulhões
E.C. F. SOUZA	UNESP	J.A. Varela
T. R.GIRALDI	UFSCar/LIEC	J.A. Varela
G. C.PETRUCELLI	UFSCar/LIEC	E. R. Leite
L. P. S. SANTOS	UFSCar/LIEC	E. R. Leite
C. M. BARRADO	UFSCar/LIEC	E. R. Leite
F.R. DIAS	IFSC/USP	A. C.Hernandes
C.N. SANTOS	IFSC/USP	A. C.Hernandes
A.M. FLORES	IFSC/USP	A. C.Hernandes
L.J.Q. MAIA	IFSC/USP	V. R. Mastelaro

UNDERGRADUATED STUDENT

NAME	Institution	Advisor
E. C. C. SOUZA	IPEN	R. Muccillo
C. M. MARUCCHI	IPEN	R. Muccillo
É. CAPRONI	IPEN	R. Muccillo
F. H. S.RIBEIRO	IPEN	R. Muccillo
J. T. SANTOS	IPEN	R. Muccillo
L. FRANCHI	IPEN	E.N.S. Muccillo
A. MANCINI	IPEN	E.N.S. Muccillo
É.S. GRIGIO	IPEN	E.N.S. Muccillo
P.C. M. BABA	IPEN	E.N.S. Muccillo
S.S. ALMEIDA	IPEN	E.N.S. Muccillo
S. M. BARRIONUVEVO	UNESP	M.A. Zaghete
L.G. SILVA	UNESP	M.A. Zaghete
T. CALVO	UNESP	M.A. Zaghete
J. L. AMARAL	UNESP	M. Cilense
R. D. ADATI	UNESP	M. Cilense
L.G.S. PEREIRA	UNESP	J.A. Varela
L. F. VALADARES	UNESP	J.A. Varela
J. C. BRUNO	UNESP	J.A. Varela
K. A. PERON	UNESP	M.A. Zaghete
L. O. COELHO	UNESP	M.A. Zaghete
F.O. SOUZA	UNESP	M.A. Zaghete
P. RAVAGNOLLI JÚNIOR.	UNESP	M.A. Zaghete
M. L. MORETTI	UFSCar/GSM	W. A. Ortiz
F. P. CARVALHO	UFSCar/GSM	W. A. Ortiz
A. P. C. K. LIMA	UNESP	L. A. Perazoli
K. S. FREITAS	UFSCar/LIEC	L.O.S. Bulhões
J.CÉSAR	UFSCar/LIEC	L.O.S. Bulhões
J.R. MORAES	UFSCar/LIEC	L.O.S. Bulhões
D. S. CASALI	UFSCar/LIEC	L.O.S. Bulhões
V. SOLIMOSSY	UFSCar/LIEC	L.O.S. Bulhões
J. ARANTES	UFSCar/LIEC	L.O.S. Bulhões
R. B. NOGUEIRA	UFSCar/LIEC	L.O.S. Bulhões
F. L. OLIVEIRA	UFSCar/LIEC	L.O.S. Bulhões
M. A. NAPOLITANO	UFSCar/LIEC	L.O.S. Bulhões
V. C. FERNANDES	UFSCar/LIEC	L.O.S. Bulhões
C. GONÇALVES	UFSCar/LIEC	E. C. P. Souza
P. GROSSI	UFSCar/LIEC	E. C. P. Souza
B. O. SANTIN	UFSCar/LIEC	E. C. P. Souza
P. C. COLPA	UFSCar/LIEC	E. C. P. Souza
A. L. ARAUJO	UFSCar/LIEC	E. R. Leite
L. A.L. TOMASELLI	UFSCar/LIEC	E. R. Leite
E. I. HORIKOSHI	UFSCar/LIEC	E. R. Leite

UFSCar/LIEC – Universidade Federal de São Carlos – Laboratório Interdisciplinar de Eletroquímica e Cerâmica

UNESP – Universidade Estadual Paulista/Instituto de Química – Araraquara

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

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

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

1.3 – Results of the Research Division (Basic Research)

List of International and National publications

1. "Sintering and characterization of PLZT (9/65/35)", M. CERQUEIRA, R.S. NASAR, E.R. LEITE, E. LONGO, J.A. VARELA , Ceramics International 26, 231-236 (2000).
2. "Synthesis of Ultra-Fine Columbite Powder $MgNb_2O_6$ by the Polymerized Complex Method", E. CAMARGO, E. LONGO, E. R. LEITE, J. Sol-Gel Technol. 17 111-121 (2000).
3. "$Ba_{1-x}Sr_xTiO_3$ thin films by polymeric precursor method", F. M. L. PONTES, E. LONG, J.H. RANGEL, M.I.B.BERNARDI, E.R. LEITE, J.A. VARELA, Mat. Lett. 43 249-253 (2000).
4. "Low temperature synthesis and electrical properties of $PbTiO_3$ thin films prepared by the polymeric precursor method" Thin Solid Films F.M.L. PONTES, E. LONGO, J.H. RANGEL, J.A. EIRAS, E.B. ARAUJO, E.R. LEITE, J.A. VAR ELA, Thin Solid Films 366, 232-236 (2000).
5. "Effects of the post-annealing atmosphere on the dielectric properties of (Ba, Sr) TiO_3 capacitors: Evidence of an interfacial space charge layer", F.M.L. PONTES, E. LONGO, J.A. EIRAS, E.B. ARAUJO, E.R. LEITE, J. A. VARELA, Appl .Phys. Lett. 76, 17, 2433-2437 (2000).
6. "Hot pressed 9.5/65/35 PLZT prepared by the polymeric precursor method", B.D. STOJANOVIC, M.A. ZAGHETE, C.O. PAIVA-SANTOS, M. CILENSE, R. MAGNANI, E. LONGO, J.A. VARELA, Ceramics International, 0, 1-6 (2000).
7. "Microstructure and dielectric properties of (Ba,Sr) TiO_3 thin film produced by the polymeric precursor method", F.M. PONTES, E.B. ARAUJO, E.R. LEITE, J.A. EIRAS, E. LONGO, J.A. VARELA, M.A. PEREIRA-DA-SILVA, J. Mater. Res., 15, 5, 1176-1180 (2000).
8. "Effect of Ta_2O_5 doping on the electrical properties of 0.99 SnO_2 . 0.01 CoO ceramics", A.C. ANTUNES, S.M. ANTUNES, S.A. PIANARO, J. Mat. Sci. 35, 1453-1458 (2000).
9. “Photoluminescence of disordered ABO_3 perovskites”, P.S. PIZANI, E.R. LEITE, F.M. PONTES, E.C. PARIS, J.H. RANGEL, E.J. LEE, E. LONGO, P. DELGADO AND J.A. VARELA, Appl. Phys. Lett. 77, 6, 824-826 (2000).
10. “Correlation Between the Surface Morphology and Structure and the Photoluminescence of Amorphous $PbTiO_3$ Thin Film Obtained by Chemical Route”, F.M. PONTES, E.R. LEITE, E. LONGO, J.A. VARELA, P.S. PISANI, C.E.M. CAMPOS AND F. LANCIOTTI, Adv. Mater. Opt. Electron., 10, 81-89 (2000).
11. “Epitaxially Grown $LiNbO_3$ Thin Film by Polymeric Precursor Method”, V. BOUQUET, M.I. B. BERNARDI, S.M. ZANETTI, E.R. LEITE, E. LONGO, J.A. VARELA, M.GUILLOUX VIRY, A PERRIN, J. Mater. Research, 15 [11] 2446-2453 (2000).
12. “An alternative chemical route for synthesis of $SrBi_2Ta_2O_9$ thin film”, S.M. ZANETTI, E.R. LEITE, E. LONGO, E.B. ARAUJO, A J. CHIQUITO, J.A EIRAS AND J.A VARELA, J. Mater. Research, 15 [10] 2091-2095 (2000).

13. “Nature of the Schottky-type barrier of highly dense SnO2 systems displaying nonohmic behavior”, P.R. BUENO, M.R. DE CASSIA-SANTOS, E.R. LEITE, E. LONGO, J. BISQUERT, G. GARCIA-BELMONTE AND F. FAB REGAT -SANTIAGO, J.Appl. Phys., 88[1] 6541-6544 (2000).
14. “Preparation and properties of ferroelectric $BaTiO_3$ thin films produced by the polymeric precursor method”, E.J.H. LEE, F.M. PONTES, E.R. LEITE, E. LONGO, Journal of Materials Science Letters, 19 1457-1459 (2000).
15. “High dielectric constant of $SrTiO_3$ thin films prepared by chemical process”, F.M. PONTES, E.J.H. LEE, E.R. LEITE, E. LONGO, Journal of Materials Science 35 4783-4787 (2000).
16. “Preparation, crystal structure determination and properties of adducts of indium methylene compounds with group 15 donors”, L.D. FELIX, C.A.F. OLIVEIRA, R.K. CROSS, C. PEPPE, M.A. BROWN, D.G. TUCK, M.Z. HERNANDES, E. LONGO E F.R. SENSATO, J. organometallic Chem. 603 203-207 (2000).
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1.4 –Results of the Innovation Division

Innovation	Research Subproject	Situation
Development of industrial process for production of nanoparticles of niobium oxide for application in electronic ceramics; Brazilian Patent (PI 0103280-1, 9 Aug. 2001).	CBMM Project	Under development
Improvement of the regional competitive condition of Porto Ferreira Ceramic Park; 1)conversion of the 17 continuous electric kiln to gas firing, promoting the duplication of production capacite and reduction in 60% of electric consumption; 2) development and implantation of 5 new batch formulation, improving the technical caracteristics; 3) estabilishment of a conceptual base as a design trade mark for the ceramic ware produced in Porto Ferreira; This tree action lines has confered international competitivity for the Porto Ferreira producties.	Porto Ferreira Project	Under development
Development of a semiconducting enamel for application in the electric insulators surface; As result of this development the company is able to compete with the international market.	Santana Project	Under development
Controlled oxygen addition in ceramic tiles roller kilns*;* The innovation was implanted in industrial scale and has be commercialized and patented in several countries including: USA *US 392.292*, Brasil *PI0004049* and European Community *EP 1.083.397A1*. Method for Producing Resistant Refractories; An additional innovation resulted from the study of corrosion on sílica refractories for glass furnaces leading to another patent filed in USA *US6,200,631B1* and Canada*A1 2,251,482*.	WMartins/PRAXAIR Project	Concluded Concluded
The innovation consisted on the use of Barium Celsian as the bonding phase of the SiC grains instead of Si_3N_4. The new brick was much easer to process and its performance is just as the same. The Brazilian patent was issued under the number PI – 9307927-3	COSIPA Project	Concluded

Sinter Plant Refractories Development of Alumina Mullite refractories, with no free silica in the matrix and presenting a narrow pore size distribution have the tendency to be more resistant to the service conditions in the Sinter Plant Ignition Furnaces. The implementation of this project leaded to an estimated yearly economy of US$ 530,000.00.	CSN Projects	Concluded
Blast Furnace Internal Lining Data survey obtained in the Post Mortem study. The implementation of these projects leaded to an estimated yearly economy of US$ 450,000.00.		Concluded
Refractory Lining of the Blast Furnace Hot Air Line In the overall circuit of hot air in the Blast Furnaces some projects were undertaken. Among those projects are The Enlargement of the Useful Life of the Ceramic Burners of the Blast Furnace Stoves and Diagnosis of the Coating Conditions of the Blast Furnace Tuyere Stocks. The implementation of these projects leaded to an estimated yearly economy of US$ 300,000.00.		Concluded
Refractory Lining of Blast Furnace Tap Hole The project of Adjustment of the Composition of Tap Holes Mortar to the Operational Conditions of the Blast Furnace, caused an estimated economy of US$ 150,000.00 per annum for CSN.		Concluded
Refractory Lining of Blast Furnace Troughs Identification of the Wearing Mechanism and Specifications of Refractories for Blast Furnaces Troughs and Development of Refractory Concrete with Low Cement Content to be Used in Blast Furnaces Troughs saved about US$ 300,000.00 per annum for CSN.		Concluded
Refractory Lining of Blast Furnace Hearth The projects Analysis of the Drilling Samples from the Blast Furnace # 3 Hearth, Process of Recovering and Machining of Carbon Blocks to be Used in the Blast Furnace # 3 Hearth, Chemical Deposition of Titanium in Carbon Blocks of the Blast Furnace # 3 Hearths for Enlarging the Hearth Campaign and		Concluded

Process for the Recovering of Carbon Blocks of the Blast Furnace Hearth leaded to an yearly economy of about US$ 684,000.00 per annum for CSN. As it can be noticed these projects resulted in an indirect impressive money savings for CSN, what was publicly acknowledged.		
1 "Mecanismos de Proteção de Filme Espesso e Interação com Refratários de Al_2O_3/SiC/C e MgO/C, I.M.G. SANTOS, S.S. CAVA, R.M. ANDRADE, C.A. PASKOCIMAS, S.M. JUSTUS, E.R. LEITE, E. LONGO, S.N. NASCIMENTO, O.R. MARQUES, J.A. VARELA, Ceramic News, 7 (1) (2000). 2 "Mecanismo de Formação de Filme Espesso para Proteção de Refratários à Base de Carbono", I.M.G. SANTOS, S.S. CAVA, C.A. PASKOCIMAS, E.R. LEITE, E. LONGO, S.N. NASCIMENTO, O.R. MARQUES, J.A. VARELA, Ceramic News, 7 (1) (2000). 3 "Mecanismo de corrosão em fornos de ignição da CSN", S.M. JUSTUS, S.N. SILVA, E. LONGO, J.A. VARELA, E.R. LEITE, R.A. MAGNANI, C.A. PASKOCIMAS, L.E.B. SOLEDADE, O.R. MARQUES, Metalurgia & Materiais, 37-40 (2000). 4 "Key features on alumina/magnesia/graphite refractories for steel ladle lining", W.S. RESENDE, R.M. STOLL, S.M. JUSTUS, R.M. ANDRADE, E. LONGO, J.B. BALDO, E.R. LEITE, C.A. PASKOCIMAS, L.E.B. SOLEDADE, J.E. GOMES, J.A. VARELA, J. Eur. Ceram. Soc. 0, 1-9 (2000). 5 “Key Features on Alumina/Magnesia/Graphite Refractories for Steel Laddle Lining”, W.S. RESENDE, M. STOLL, S.M. JUSTUS, R.M. ANDRADE, E. LONGO, J.B. BALDO, J.A. VARELA, C.A. PASKOCIMAS, L.E.B. SOLEDADE, J.W. GOMES, Journal of European Ceramic Society, vol. 20, pp-1419-1427, 2000.	Published Papers Related to the Industrial Projects	Concluded

6	"Medidas Experimentais da Difusividade Térmica de Monoporosa", A.P.F. ALBERS, W.N. SANTOS, R. TAYLOR, BOSCHI, A,O. AND J. B. BALDO, Ceramic News Special edition, vol. 7, No. 1, 36-39, 2000.		
7	"The thermal Diffusivity Behavior of Typical Fast Fired Porous Tiles", A.P.F. ALBERS, W.N. SANTOS, R. TAYLOR, BOSCHI, A,O. AND J. B. BALDO, Tile and Brick International, vol. 16, N0. 1, 18-23, 2000.		
8	Influência da cinética de oxidação no controle da atmosfera de fornos de revestimentos cerâmicos", S. Cava, E. Longo, C.A. Paskocimas, J.A. Varela, A. Tasca, T. Mendonça, C.G. Herter e J.C. Barbosa Jr., Cerâmica,46,298(2000).		
9	"Method for reducing defects in ceramic tiles production by kiln atmosphere control, Part I: Theoretical and Experimental Aspects", E. LONGO, S. CAVA, J.W. GOMES, C.G. HERTER, C.A. PASKOCIMAS, L.E.SOLEDADE, A. TASCA, J.A. VARELA, Tile & Brixk Int., 17, 40-44 (2001).		
10.	"Saving money in the iron and steel industry through better undestanding of refractory linings corrosion mechanisms", S.M. JUSTUS, R.M. ANDRADE, S.S. CAVA, L.E.B. SOLEDADE, I.M.G. SANTOS, E.R. LEITE, E. LONGO, S.N. SILVA, O.R. MARQUES, J.B. BALDO, C.A. PASKOCIMAS, J.A. VARELA, FEATURE 9-13 (2001).		

1.5 – Continuous Education and Dissemination Results

ACTIVITY	RESEARCH SUBPROJECT
VI WINTER SCHOOL *"CHARACTERIZATION TECHNIQUES OF NANOSTRUCTURED MATERIALS"* Prof. Dr. Edson Roberto Leite – PH.D. Student Felenon Martinho Lima Pontes – Dr. Paulo Noronha Lisboa Filho (Universidade Federal de São Carlos) *"CORROSION IN INORGANIC MATERIALS"* Prof. Dr. Elson Longo, Ph.D. Student Ricardo Magnani Andrade, Dr. Carlos Alberto Paskocimas (Universidade Federal de São Carlos) *"THERMAL ANALYSIS: INTERPRETATION of the TG, DTA and DSC CURVES"* Prof. Dr. Massao Ionashiro (Universidade Estadual de São Paulo – Araraquara)	**Undergraduated and Graduated Level**
SHORT-COURSES *LECTURES* "**Solid Phase Microextraction"** Prof. Dr. Maria Eugênia Nassur – Universidade de Ribeirão Preto UNAERP **"Nuclear Magnetic Ressonance Applied to the Study of Materials"** Prof. Dr. José Pedro Donoso Gonzalez -Departament of Physics and Computer Sciences - São Carlos Institute of Physics - Universidade de São Paulo	**Undergraduated and Graduated Level**

MCDCM Seminars "Laser Processing of Ceramic Materials" Prof. Dr. Antonio Carlos Hernandes "Some examples of recent research in laboratory of solid state and inorganic chemistry in Rennes (France): - oxychlorides in niobium clusters chemistry - thin films of complex materials by pulsed laser deposition" Prof. Dr. André Perrin - Prof. Dr. Christiane Perrin Université de Rennes – France "Innovation Program at MCDCM: University-Company Interaction" Prof. Dr. Elson Longo da Silva LIEC/DQ/UFSCar and MCDCM – Director "SnO_2 SINTERING and APPLICATIONS" Prof. Dr. José Arana Varela LIEC/IQ/UNESP "Effect of the atmosphere upon the crystallographic orientation and microsctructure of thin films" Prof. Dr. MARIA APARECIDA ZAGHETE IQ-UNESP/Araraquara - MCDCM "Research In Amorphous And Nanostructured Materials" Prof. Dr. Edson Roberto Leite LIEC-DQ/UFSCar – - MCDCM "Preparation of Materials with Unusual Properties" Prof. Dr. Ernesto Chaves Pereira LIEC-DQ/UFSCar – - MCDCM "Corrosion in Glass Furnace Refractories" Dr. Carlos Alberto Paskocimas, LIEC – MCDCM "Use of XPS for the Analysis of Industrial and Scientific Samples" Prof. Dr. Wido Herwig Schreiner Department of Physics - UFPR "MAGNETISM – SOME CHALLENGES FOR THE 21th CENTURY" *Prof. Dr. Adilson Jesus Aparecido de Oliveira* GSM/DF/UFSCar	**Undergraduated and Graduated Level**

GRADUATE LEVEL COURSES OUTSIDE – MCDCM - **State of Paraná –** Universidade de Ponta Grossa .Solid State Kinetics Elson Longo .Phase Transformations José Arana Varela Courses of 60 hours of classes - **State of Rio Grande do Norte –**Universidade do Rio Grande do Norte .Use of the Pechini Method for Obtaining Electronic Ceramics Elson Longo Courses of 30 hours of classes - **State of Maranhão –** Centro Federal de Educação Tecnológica de São Luis .Ceramic Processing Carlos Alberto Paskocimas .Physical Ceramics José Arana Varela .Techniques of Materials Characterization Edson Roberto Leite .Solid State Thermodynamics Elson Longo Courses of 60 hours of classes	**Undergraduated and Graduated Level**
Paper published in the Revista de Ensino de Engenharia, v. 19, n.1, pg 37-46 (2000) Title: Estrutura e ênfase da disciplina cerâmicas refratárias no curso de graduação em Engenharia de Materiais da UFSCar	**Undergraduated and Graduated Level**
HIGH SCHOOL CONFERENCES *.CEFET – São Luis – Maranhão* Defects in Ceramic Linings Carlos Alberto Paskocimas *.CEFET – São Luis – Maranhão* SnO_2–based Varistor Materials Elson Longo *. Colégio Diocesano La Salle - São Carlos / SP* *. EEPG Prof. Antonio Militão de Lima - São Carlos / SP* . Artistic Ceramics Graziela Pereira Casale Ingrid Tavora Weber Alessandra Zenatti	**High School Level**
Ceramic Artisans Brochure, in partnership with the "Conselho da Comunidade Solidária"	Craftsmen Level
Videos about a series of reports covering the activities of MCDCM in the Artistic Ceramic Park at Porto Ferreira. (inclusive a report presented in the TV Cultura "Programa Diário Paulista")	Craftsmen Level

2. RESULTS IN BASIC RESEARCH

In the first year of the Multidisciplinary Center For Development of Ceramic Materials (MCDCM) (2000/2001) was detected a huge increase in the research activity, which resulted in a high productivity, taking into account the number of papers published in this period. The increase in the research activity was mainly determined by the strong interaction among the several groups of the MCDCM and by the interaction of MCDCM groups with other research groups in São Paulo state and in other Brazilian states. We can say that the interaction was the key strategy of the first year . It is important to point out that the driving force for this strong interaction was the advent of the MCDCM.

The analysis of the research activity in the first year will be described by sectors.

1) Chemical Synthesis

In this area there are two main research topics, i.e., nanoparticle synthesis and synthesis of ferroelectric oxides by a Sol-Gel like process. In nanoparticle synthesis the principal focus is the synthesis of SnO_2 nanoparticles for gas sensor applications. Sensor performance is very significantly improved when the crystallite size decreases.

In the recent communication published in Adv. Materials, we describe a new procedure to process SnO_2 nanoparticles with good gas sensor properties, based on particle size control, using additives such as Nb_2O_5 to control nucleation and particle growth during the process of synthesis. Preliminary gas-sensing measurements were made employing ethanol as the testing gas and using thin films prepared from a powder suspension of doped and undoped SnO_2 particles. These preliminary measurements suggest that the doped SnO_2 have good gas-sensing properties. In other words, Nb_2O_5 can be used to control particle size. Since the process is simple and based on water solution synthesis using inexpensive reagents, this technology can be implemented in the near future. Implementation of this technology will introduce high performance gas sensors in the market. Therefore, the impact in terms of commercialization is expected to occur soon.

Considering the synthesis of ferroelectric oxides, the main research topics were: synthesis of $PbTiO_3$ by a Sol-Gel like process (polymeric precursor method) and processing of nanostrucured $PbTiO_3$ by high energy mechanical milling.

Considering the $PbTiO_3$ (PT) synthesis, a gradual transition from cubic to tetragonal perovskite PT was observed with the increase of the calcination time at 444°C. HRTEM results showed that the cubic perovskite PT particles have a size of around 5 nm. The identification of cubic perovskite PT as an intermediate phase

supports the hypothesis that the chemical homogeneity was kept at the molecular level during the synthesis process, with no cation segregation. This work was published in the J. Am. Ceram. Soc. A significant result obtained is this first year was the processing of nanostructured $PbTiO_3$ with photoluminescence behavior by high energy attrition mill. The results were published in the Appl. Phys. Letters. An alternative method to process nanostructured wide-band gap semiconductors with active optical properties such as PL is described .

2) Semiconductors and Ferroelectric Materials

The main research area of this sector are ferroelectric thin films and polycrystalline semiconductors based on SnO_2 and TiO_2 ceramics.

The research goal of ferroelectric thin films is their application in Ferroelectric memories (FeRAM and DRAM) as well as in electrooptics application. In this area, we are using the polymeric precursor solution method (a modified Pechini process) and obtained excellent results in morphology as well as in electrical and optical properties.

For electrooptical application we have been studying $LiNbO_3$ based thin films deposited on sapphire substrates. The chemical route used allowed to obtain epitaxial $LiNbO_3$ thin films with good optical properties. The results of this work have been published on the Journal of Materials Research. Thin films of PLZT have also been considered and our preliminary results are very attractive by obtaining excellent films by using this chemical method. The preliminary results on morphology, crystal structure and orientation have been published on Key Engineering Materials, Applied Surface Science and Thin Solid Films.

For memory application, several compositions have been studied during this first year. For DRAM application, the $SrTiO_3$ thin films displayed excellent properties such as high dielectric constant, low leakage current, low dielectric loss and high charge storage density. In the same way, $Ba_{1-x}Sr_xTiO_3$ solid solution and lanthanum modified $PbTiO_3$ thin films have been studied in this first year and the properties obtained in these films deposited from a polymeric solution are very attractive for DRAM application. For FeRAM application, a limiting property is the fatigue behavior on cycling. Several compositions were considered in this first year. The potential phases considered are the bismuth layer system such as $SrBi_2Ta_2O_9$ and $SrBi_2Nb_2O_9$, the solid solution BST and a multilayer film of $BaTiO_3$ and $SrTiO_3$. All these phases displayed very good ferroelectric behavior. In particular, the $Ba_{1-x}Sr_xTiO_3$ solid solution presented good fatigue behavior (no degradation after 10^8 cycles). Moreover, the combination of $BaTiO_3$ and $SrTiO_3$ layers presented the most promising behavior for fatigue-free films. No degradation of polarization was observed after 10^{10} cycles. All these results were

published in periodicals such as Thin Solid Films, Journal of Applied Physics, App. Physics Letters, J. Mater. Res., J. Eur. Ceram. Soc. and others.

Considering the polycrystalline semiconductors, the research focus of this period was the development and characterization of varistors devices based on SnO_2 and TiO_2. The sensitivity of SnO_2-based varistors and titanium oxide based varistors have been studied during this first year. High non-linearity coefficients were obtained and the major advantage of these systems lies in their apparently simple microstructures and their high electrical stability. The effect of small additions of La_2O_3, Pr_2O_3 and Al_2O_3 are similar to that previously reported for Cr_2O_3. These oxides are apparently segregated at the grain boundary region and may alter the potential barrier at the grain boundary, affecting varistor properties. Because of their non-equilibrium nature, the highest barrier properties are dependent on processing variables such as cooling rate. The reversible behavior of the non-ohmic properties with the heat treatment atmosphere is related to the potential barrier formation and to oxygen species at the grain boundaries that cause trapping states and a Schottky like barrier. This reversibility is assumed to be associated with the degree of oxidation (when the material is treated in an oxygen rich atmosphere) or the degree of reduction (when the material is treated in a nitrogen rich atmosphere) of metal oxides precipitated at the grain boundary. Then the main role of certain transition metal oxides such as La_2O_3, Pr_2O_3, Al_2O_3 and Cr_2O_3 is to provide the grain boundary region with oxygen and increase the non-linearity of the varistor system. Thus, the barrier characteristics can be affected by oxygen species that can change its charge at grain boundary surface. Thermal post-treatment in a nitrogen-rich atmosphere decreases the non-linear properties of these varistors. However, repeating the thermal treatment in an oxygen rich atmosphere can recover the non-linear properties to nearly their original values. Therefore, the sensitivity of SnO_2 and TiO_2 based varistors can be attributed to the degree of oxidation at the grain boundary region. Several papers have been published in this first year in periodicals such as Appl. Phys. Letters, J. Eur. Ceram. Soc., Ceramics International and J. Materials Science.

3) Optical and Electrochromic Materials

In optical materials, the most significant result obtained in this first year was the development of amorphous oxides with intense photoluminescence at room temperature. Our group recently demonstrated that $ATiO_3$ amorphous titanates, where A=Pb,Ca,Sr and Ba, processed by a soft chemical process called the polymeric precursor method, displayed intense photoluminescence (PL) at room temperature (papers published in the Appl. Phys. Lett., Adv. Mater. for Optical and Electronic and Appl. Phys. A.). We reported several interesting properties of these amorphous titanates, including the fact that the PL emission wavelength is

related to the exciting wavelength and that PL phenomena are related to the amorphous state . These studies revealed important aspects. Firstly, a simple water-based chemical process was used, allowing amorphous titanates to be processed at temperatures as low as 250ºC in the form of thin films or particles. Secondly, theoretical and experimental results suggest that amorphous titanate is composed of a Ti-O network. The charge of the A cation must be compensated by negatively charged non-bridging oxygens (NBO) and the PL phenomenon is associated to this defect. The bond between the A cation and oxygen is basically ionic. This research area is a typical example of the interaction between a MCDCM research group and a research group outside MCDCM.

During the last year we investigated the doping effect on different electrochromic systems such as Nb_2O_5, WO_3, CeO_2-TiO_2 and CeO_2-SnO_2. The first two systems are active electrochromic materials and the last two systems are counter electrodes, working as active electrochemical electrodes, but are optically inactive. A correlation between the doping and the electrochemical and optical properties of the films was obtained.

A significant increase of the electrochromic efficiency was observed for the doped Nb_2O_5 and WO_3 films where the maximum efficiency was related to the segregation of a secondary phase at the grain boundary region. The optimization of the doping conditions was achieved by using an experimental planning, with the consequent decrease of the number of experiments. The most important results were published in Electrochimica Acta and Journal of Non-Crystalline Solids.

Finally, the intercalation mechanism that occurs during the film reduction is under investigation, using electrochemical impedance and spectroscopy. From these studies, it will be possible to propose a mechanism for the mass transport reactions that occur inside the oxide film and a mechanism for the transmittance variation in the visible region.

4) Crystal Growth and Non-Crystalline Materials

In crystal growth and non-crystalline materials, two special results should be pointed out: the optimizing of the pulling process of single-crystal fibers from different oxides and the sintering of $Bi_4Ti_3O_{12}$ ferroelectric ceramics using CO_2 laser. Laser sintering is a very efficient process, providing ceramics with high density in a time span about 16 times shorter than the time spent in a conventional furnace. It is possible to reach pore-free surfaces in a short time. This is a very promising result to be applied in an industrial scale process. The laser heated pedestal growth technique, which is used for preparing single crystal fibers, involves very large temperature gradients at the growth interface. While this is often useful, it can also be problematic for some material systems. We developed a new configuration, introducing an additional optical component into the laser

beam path. This created an optical aberration at the laser focal point, thereby redistributing the thermal energy over a larger molten surface area. With this modification the thermal gradients were decreased from 3800 ± 100°C/cm to 2700 ± 100°C/cm during the growth of Bi-Sr-Ca-Cu-O (2212) single crystal fibers, showing that it is possible to control the thermal gradients by handling the laser beam before it enters the growth chamber.

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

The research duties of the Superconductivity and Magnetism Group in the original proposal were focused on the design, fabrication and characterization of microdevices based on magnetic and superconducting thin films. This activity is ultimately dependent on the existence of a Pulsed Laser Deposition (PLD) apparatus, especially designed to produce good-quality thin films of the materials of interest. The purchase of the PLD has been postponed to the third year – a decision made in consonance with the overall strategy for the Center´s activities. Nonetheless, the Superconductivity and Magnetism Group maintained its purposes along this line, carrying out a vigorous program for developing good quality specimens which, ultimately, will be used as targets for the fabrication of the films and devices originally proposed. The program includes the study of specific properties of the samples, as well as the correspondence between the measured magnetic response and the processing and post-prepared heat-treatments of the specimens. This program resulted in series of new samples, obtained using several alternative routes and treated according to a variety of routines. These, in turn, were achievements intimately related to the development of specific research programs involving post-docs and students of all levels. As a consequence, a meaningful number of students have completed their work, and a significant number of papers have been published in good scientific journals, and nine others have been accepted .

3. TECHNOLOGICAL RESULTS

In terms of technological innovations, the center developed several projects of strong industrial interest, which resulted in several patents and papers . The interaction with industries was conducted through specific projects with the different segments. The most relevant projects are:

a)Development of an industrial process for the production of nanoparticles of niobium oxide for application in electronic ceramics. This project was contracted by Companhia Brasileira de Metalurgia e Mineração (CBMM) and resulted in an innovative process for obtaining nanoparticles aiming at meeting the external market of niobium oxide powders for the electronic ceramics. Several alternative process were developed, which lead to the application of a Brazilian patent (PI 0103280-1, August 9, 2001). As a result of this development, a new contract was celebrated further extending the project for one year.

b)Presently the artistic and china ware ceramics are the most competitive in the international market. In order to improve the regional competitive conditions, it was signed an extended contract project with 37 industries of the Ceramic Park of Porto Ferreira (SP). The project focused three main line actions: 1) conversion of continuous electric kiln to gas firing; 2) development of batch formulation; 3) establishment of a conceptual base as the design trade mark for the ceramic ware produced in Porto Ferreira. The energy conversion of the furnaces permitted the duplication of the industrial production using the same facilities and also an average reduction by 6.5 times of the electric energy consumption of the industrial plants. The new batch formulation, using a new set of raw materials, allowed a cost reduction with raw materials as well as an improvement of the properties of the final products. It can be emphasized the reduction of water absorption from 28% to 13% in the ceramic ware. The design project consisted in modifying the geometry of ceramic articles, the design of ceramic products as well as to propose the idea of that the segmentation of the product lines in small industries bring advantages in terms of production and commercialization of the ceramic ware.

c)In the area of electric ceramics it was established a project between MCDCM and Isoladores Santana Inc. aiming at developing a semiconducting enamel for application in the electric insulator surfaces. The objective was to decrease the damage due to electric field breakdown, consequence of the accumulation of charge on the insulator surfaces. It was developed in our laboratory a enamel based on tin oxide. The enamel was tested in the insulators achieving excellent results. As a result of this development, the company can now compete in the international market.

d)In the area of tiles and refractories, the White Martins/Praxair gas company supported two projects. Considering the deleterious aesthetic effects and the overall decrease in quality resulting from underglazed stains, promoted by sources of reduced iron oxide and organic matter, the innovation consists in the use of oxygen gas properly delivered through a special technique at the firing zone of roller kilns. The main achievements were the complete elimination of stains and an impressive jump of 30% in productivity due to

optimized firing schedule, made possible by the innovation. The innovation was patented in several countries including: USA 392292, Brazil PI 0004049 and European Community EP 1.083.397 A1.

An additional innovation resulted from the study of corrosion on silica refractories for glass furnaces leading to another patent filed in USA 6,200,631B1 and Canada A12,251,482 from April 27, 1999. In this project a Sn, Zr and/ or Ce organometallic precursor was used of to fill up the pores of the silica brick. After firing, the elimination of the organic precursor occurs, resulting in a metal oxide that will prevent the sodium corrosion. This is a typical example where a technology used for electronic ceramics was used to solve an industrial problem.

e) Several joint projects were undertaken with the partnerships of several Brazilian Steel Companies. The principal projects are listed bellow:

COSIPA (Companhia Siderúrgica Paulista)

The blast furnace environment, notably in the bosh area is rich in very aggressive alkali vapors (Na, K, Zn). The successful use of Silicon Nitride bonded Silicon Carbide was a great achievement for prolonging the blast furnace campaign. However, the high cost of this refractory and the necessary cooling of the lining created a disadvantage. The innovation consisted on the use of Barium Celsian as the bonding phase of the SiC grains instead of Si_3N_4. The new brick was much easier to process and its performance is just the same. The Brazilian patent was issued under the number PI – 9307927-3

CSN (Companhia Siderúrgica Nacional)

The world steel production has increased, in spite several economical and financial crises. The steelmaking industry is continuing to reduce costs and to increase the productivity in Western Europe[1]. The optimization of this important productive sector depends upon a better performance of the refractories. The modern refractory must display three essential qualities: low cost, high corrosion resistance performance and good thermo-mechanical properties. The equilibrium between these three parameters involves the deep understanding of the wearing processes of the refractories, aiming at correctly planning the composition and microstructure of these materials.

The increase of blast furnace productivity requires the guaranty of sinter supply. With this purpose it is necessary to avoid sinter production losses due to failures in the refractory linings of the Sinter Plant Ignition Furnaces.

The sintering blend, upon entering in contact with the high temperatures of the income section of the Ignition Furnace is projected against the refractory walls, as a result of the phenomenon of hematite crepitation. The corrosion mechanism of the lining refractory from the Sinter Plant Ignition Furnace is therefore fundamentally governed by the diffusion of the wall adhered iron oxide that attacks the silica rich refractory matrix.

Laboratory simulations by the dynamic slagging test, using a synthetic Fe_2O_3 and CaO based slags, have faithfully reproduced the industrial corrosion process. Therefore, Alumina Mullite refractories, with no free silica in the matrix and presenting a narrow pore size distribution have the tendency to be more resistant to the service conditions in the Sinter Plant Ignition Furnaces. The implementation of this project leaded to an estimated yearly economy of US$ 530,000.00.

The Post Mortem study of the Blast Furnace # 3 refractories evidenced the presence of several wearing mechanisms that take place isolatedly or together. They are:

· The formation of low melting point phases produced by the combination of zinc oxide from iron bearing residues introduced in the burden with free silica, as an original constituent of the aluminous and silico-aluminous refractory.

· In situ spinel formation. This mechanism is also a consequence of the combination of gaseous zinc with aluminum oxide, forming the zinc aluminum spinel, which is accompanied by an increase in volume, promoting the tensioning of the microstructure and causing its spalling.

· Oxidation of silicon carbide and silicon nitride. The silicon carbide and the silicon nitride are oxidized by the carbon monoxide present in the Blast Furnace atmosphere, resulting in the precipitation of carbon and silica. The potassium vapor attack forms low density and low melting point phases. These phases with the temperature fluctuations inside the Blast Furnace promote the degradation of the microstructure of the refractory lining.

· The mechanism of erosion by the burden was also verified, once in certain regions of the Blast Furnace no significant concentration of phases produced by corrosion was found. In these same regions, a significant reduction in the thickness of the refractory lining was also observed.

As a consequence of the knowledge obtained in the Post Mortem study, some projects were carried out aiming at a cost reduction in the internal linings of the Blast Furnace. Such projects include the Characterization of Refractory Concretes to be Used in Robotized Projection Within the Blast Furnace; the Characterization of Refractory Concretes to be Injected in the Stack of the Blast Furnaces and the Control of Receiving Refractory Materials for the Blast Furnace. The implementation of these projects leaded to an estimated yearly economy of US$ 450,000.00.

In the Post Mortem study of the refractory lining of Blast Furnace # 3 tuyere stocks it was identified a wearing mechanism characterized by the formation of zinc rich, low-density phases that lead to the thermoclasis of the material. Physical and numerical heat transfer simulations, monitored by thermography, were also undertaken. This study concluded that the tuyere stock refractory lining was strongly corroded by the zinc oxide, from solids suspended in the in gas collected at the top of the Blast Furnace.

In the overall circuit of hot air in the Blast Furnaces some projects were undertaken. Among those projects are The Enlargement of the Useful Life of the Ceramic Burners of the Blast Furnace Stoves and

Diagnosis of the Coating Conditions of the Blast Furnace Tuyere Stocks. The implementation of these projects leaded to an estimated yearly economy of US$ 300,000.00.

The partial relining of CSN's # 3 Blast Furnace included the substitution of the four tap holes. A comparative set of laboratorial tests was undertaken, using different materials. It was concluded that the linings of Tap Holes are soon substituted by a blend of tapping mortar and industrial slags. A global analysis of the Tap Hole views it as a Materials System, with multiple functions and different requirements. In this way, one can not dissociate its project and its materials selection from its effect over the tapping mortar performance. The evaluation of the resistance toward alkaline attack merely by visual inspection, as proposed by the ASTM-C-454-77 standard, is not a faithful criterion. A more judicious evaluation involves the determination of the degradation in terms of mechanical resistance due to the alkaline attack.

The sillimanite refractories present the worst alkaline attack performance. This fact is explained by the high concentration of silica, which easily reacts with the alkalis, leading to the formation of kaliophyllite and leucite. These potassium aluminum silicates have low melting point and low density and are responsible for the degradation of the material.

The same criticism stated about the evaluation of alkaline attack resistance applies to the appraisal of the thermal shock resistance test. The graphite refractories, due to their high thermal conductivity, present a superior performance related to thermal shock.

The tap holes must be analyzed in a global way, visualizing them as a materials system with multiple functions and different requirements. In this way, their design and their selection of materials should not be dissociated of their effect upon the performance of the tapping mortars.

The project of Adjustment of the Composition of Tap Hole Mortar to the Operational Conditions of the Blast Furnace, caused an estimated economy of US$ 150,000.00 per annum for CSN.

With the increasing in productivity of CSN's Blast Furnaces, it became a must to improve the performance of the troughs, in order to allow the flow of the new production volume. In this way, the working conditions and the corrosion process of the refractories from the trough were investigated, with the objective of improving their performance.

The Blast Furnace slag contains several compounds that attack the refractory, emphasizing between them CaO and SiO_2. Those components promote the corrosion by a series of chemical reactions. The wearing mechanism is characterized by the formation of low melting point compounds, from the reaction between gehlenite, anorthite, pseudowollastonite and silica. The liquid phases formed are easily removed by the flowing of slag and liquid metal what allows the formation of a new front for the attack of corrosive reactants.

Chemical corrosion is the main wearing mechanism of the trough lining. However, the flowing conditions of metal and/or slag, the design of the trough and an efficient control of the drying and curing curves can sensibly contribute to an improvement of the performance of the materials.

The projects Identification of the Wearing Mechanism and Specifications of Refractories for Blast Furnaces Troughs and Development of Refractory Concrete with Low Cement Content to be Used in Blast Furnaces Troughs saved about US$ 300,000.00 per annum for CSN.

Six are the most important wearing mechanisms for the Blast Furnace hearth refractory. They are water oxidation, zinc attack, alkali attack, slag attack, overheating and pig iron penetration. The water oxidation reduces the fixed carbon content of the refractory. The zinc attack enriches the refractory in that element, like the alkali attack leads to higher concentration of potassium and sodium. The slag attack increases the calcium concentration. The overheating leads to the propagation of stress cracks. Therefore cracks are observable in the microstructure, promoting an increase in the porosity and poorer mechanical properties. The pig-iron penetration increases the iron content in the refractory, as well as the true density.

A diagnosis study was performed in a joint effort of LIEC and CSN. The overall conditions of the hearth lining were rather good. Therefore, the extension of the Blast Furnace Hearth campaign for five years more, was therefore possible after some local repairs have been made.

The projects Analysis of the Drilling Samples from the Blast Furnace # 3 Hearth, Process of Recovering and Machining of Carbon Blocks to be Used in the Blast Furnace # 3 Hearth, Chemical Deposition of Titanium in Carbon Blocks of the Blast Furnace # 3 Hearths for Enlarging the Hearth Campaign and Process for the Recovering of Carbon Blocks of the Blast Furnace Hearth leaded to an yearly economy of about US$ 684,000.00 per annum for CSN.

As can be noticed, the economy of these projects summed up to about US$ 2,4 million per annum for CSN, who publicly acknowledged such impressive money savings.

4. CONTINUOUS EDUCATION AND DISSEMINATION DIVISION

Certainly, the greatest challenge for our center is the diffusion of the knowledge developed in our center to the society, and especially to different levels of education. In this sense the strategy of this first year was to work hard in the undergraduate and graduate level and in the dissemination of the ceramic technology to improve o knowledge of the craftsmen who work with artistic ceramics.

The activity of the Continuous Education and Dissemination Division will be described, following the activities at the graduate, undergraduate, and craftsmen levels.

1- Graduate and undergraduate levels

MCDCM participated actively of the organization of the 6th Winter School in Physico-Chemistry and Analytical Chemistry, coordinated by Prof. Dr. Edson R. Leite. In this event were opened to undergraduate and graduate students the discussions of frontier themes and multidisciplinary research areas. With globalization and the requirement of Total Quality Management in the industries, a new profile of engineers, chemists and physicists is being asked by the producing sector. The Winter School contributes to fill this gap with objective and modern courses, focussing mainly the area of Ceramics. The number of participants in 2001 was of 248 registrations (engineers, physicists, chemists, biologists and mathematicians). The highest student concentration was from the universities located at São Carlos, nevertheless participants from USP - Ribeirão Preto, USP - São Paulo, UNICAMP and as far away as from Federal Universities of 12 Brazilian states were registered (see the Winter School brochure, presented in Figure 1).

Figure 1 Winter School brochure

Considering the undergraduate level, the group coordinated by the Prof. Dr. Baldo published a paper about Refractory Ceramics as a discipline of the Course of Materials Engineering. Professor Baldo is responsible for this Course at the Department of Materials Engineering at the Universidade Federal de São Carlos. The Structure and Emphasis of this course were presented, as well as their contents, with comments about their strategic role in the field of Materials Engineering and also the interdisciplinary links and pre-requisitions. This paper was presented at a renamed Brazilian magazine specialized in field of Teaching of Engineering, the Revista de Ensino de Engenharia, v.19, n.1, p.37-46, 2000.

In the undergraduate level, the LIEC group (Prof. Dr. Edson Roberto Leite and Prof. Dr. Ernesto C.P. Sousa) modified the Course of Experimental Physical-Chemistry of the Department of Chemistry from the Universidade Federal de São Carlos. They introduced new techniques such as: Differential Scanning Calorimetry (DSC), XRay Diffraction (XRD), Scanning Electronic Microscopy (SEM) and Thermogravimetric Analysis (TG). It is important to point out that the students were motivated to solve real problems such as : Analysis of PET

material for packing, analysis of electrical porcelain formulations and chemical route synthesis and characterization of YBCO superconductor.

Efforts have also been directed to improve contact with all levels of education. In particular, Drs. de Oliveira and Ortiz had active participation in FAPESP´s Pró-Ciências program. Both joined the UFSCar Physics-Mathematics team proposal and, accordingly to the approved project, prepared and delivered the course Modern Cosmology, offered to high-school teachers enrolled in the "Physics and Mathematics Integrated Project for Teachers of Public Schools". The program is intended to provide a continuous education opportunity for teachers working in public high-schools in the São Carlos area. The "Physics and Mathematics Integrated Project for Teachers of Public Schools" home page is located at:
http://www.dm.ufscar.br/profs/salvador/proci/procien01.html

Demonstration Kits have been planned to put Magnetism and Superconductivity in practice, transferring academic knowledge to off-university students. The first Demonstration Kit –"Guidelines for a demonstration experiment: magnetic levitation of a magnet repeled by a superconducting block"- was completed and successfully tested in High-School Science Fairs.

2 – Craftsmen Level

MCDCM carried out during 2001 a vast activity supporting the Ceramic artisans, in partnership with the Conselho da Comunidade Solidária, headed by Dr. Ruth Cardoso. Teams from MCDCM were sent to the states of Minas Gerais, Espírito Santo, Pernambuco, Piauí, Bahia, in order to teach Courses of Basic Ceramic Technology. Besides the courses, experiments were run with the goal of enhancing the formulations of ceramic pastes and the sintering control of the pieces with the goal and obtaining a better performance in their mechanical properties and in hues of the artifacts.

This teaching to the artisans was supported by a brochure that shows the different steps for obtaining a ceramic piece without defects with an adequate mechanic property. Figure 2 presents the cover of the brochure used to support the MCDCM activities in this area.

Figure 2 - The cover of the brochure used to support the MCDCM activities in this area.

3. Educational activities

Seminars have been performed at UFSCar and IPEN-SP with the purpose of increasing the scientific cooperation among researchers of different institutions. Some speeches were also presented at secondary schools in order to introduce the students to the concepts of materials science. One of the most remarkable events developed in this first year was the I ECMC (First Meeting of Ceramic Materials Center), held on February 16, 2001, in São Carlos, São Paulo. More than 180 researchers, including professors, PhD, Master, undergraduate students and staff participated of the I ECMC. Abstracts of the posters presented were recorded in CD to keep the memory of the Center.

The equipment available in the research laboratories of MCDCM were employed in a new approach of the graduate and undergraduate courses. In these courses, the students had the opportunity to be in contact to electronic microscope, X-ray diffractometer, thermal analysis equipment, and so on.

Our Ph.D. and Post-Doc students were trained to explain topics on materials science in a simple manner involving day-by-day questions. A folder entitled PALESTRAS (Speeches) was produced and is been distributed

at public schools of São Carlos and near cities containing the titles and abstracts of 13 themes like “From sand to computer”, “Advanced Ceramics: high technology at home”, “Glasses and their colors” and “The Atom and this relationship with the nature”. This folder was also included in the homepage of the Center. Schools will choose the themes to be presented.

A new project named **Ceramics in the classroom** is in the final phase of development and will be applied to the children of 10 -12 years old. Basic ceramics, glasses, whitewares and structural clay products will be focused in 13 lessons. The goal in basic ceramics is to introduce students to ceramics and enhance their ability to identify them in everyday life. In glasses the objective is to acquaint the students with properties associated with glasses. This includes both optical and structural properties. The goal in whitewares and structural clay products is to understand some of the guiding principles behind ceramic processing. These principles are especially true in the fields of whitewares and structural clay products.

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 covered news about MCDCM achievements in the Innovation Projects, emphasizing the development of refractories made in partnership with CSN and the development of glass furnace refractories with White Martins/ PRAXAIR. 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 at the Artistic Ceramic Park at Porto Ferreira, 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 .

A video about the participation of MCDCM was produced, presenting the importance of Ceramics upon the development of Porto Ferreira and the educational and technological role of MCDCM. This video will be presented to FAPESP representatives upon a future visit to MCDCM headquarters.

On the other hand, with the goal of consolidating the dissemination of knowledge, two speeches were given at the Sindicato das Indústrias de Produtos Cerâmicos de Louça, Pó de Pedra, Porcelana e Louça de Barro de Porto Ferreira, Sindicer, directed to the foremen of the industries of the Park, having as subject Characterization Techniques and Technological Perspectives Related to Ceramic Pastes and also Industrial Design.