

**SEMINARIO - TALLER**  
**NUEVOS MATERIALES INDUSTRIALES**  
**26-11-90 / 01-12-90**

**CERAMICAS AVANZADAS**  
**ADVANCED CERAMICS**

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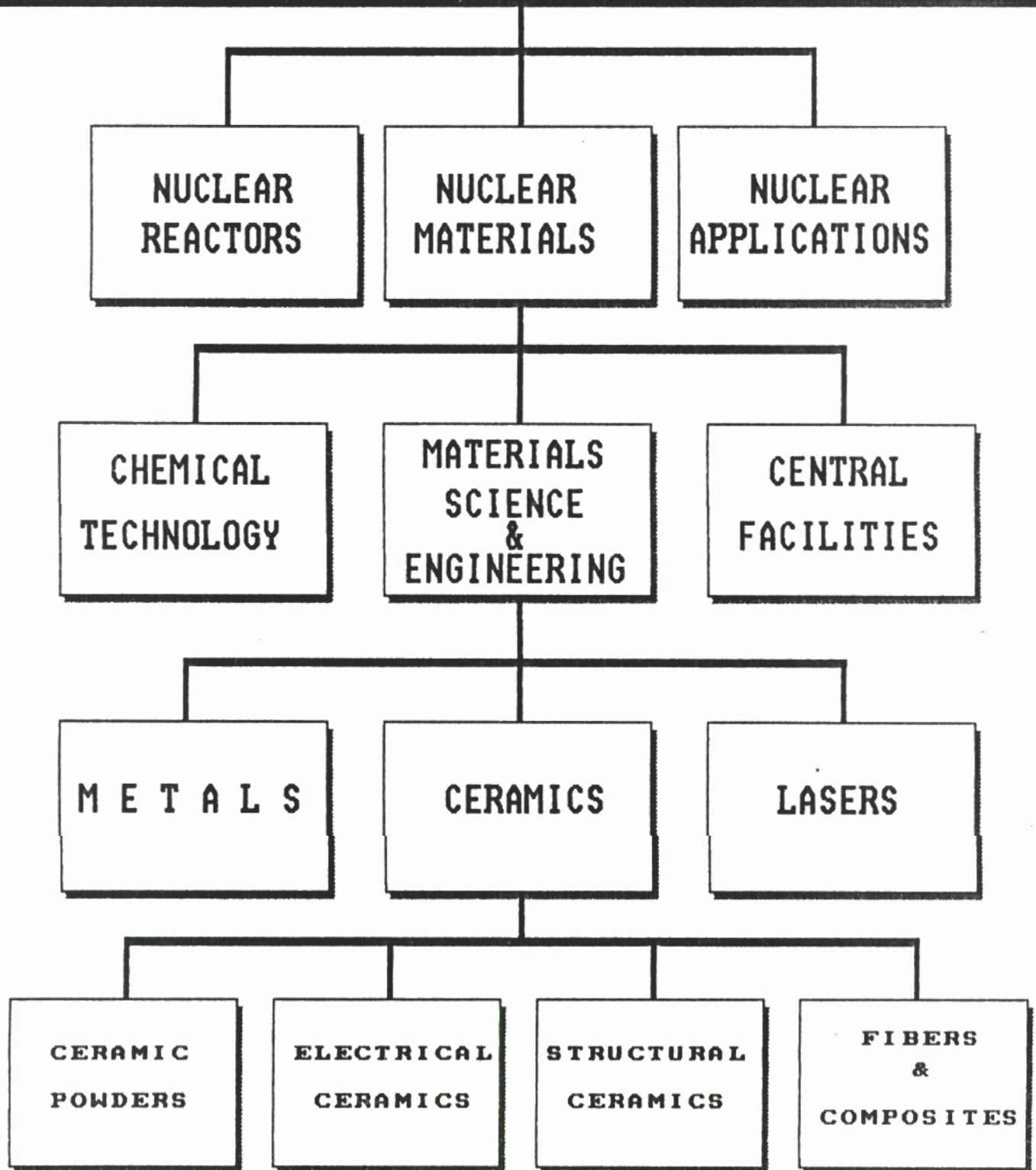
IPEN-DOC- 3866

COLEÇÃO PTC

DEVOLVER AO BALCÃO DE EMPRÉSTIMO

PTC dez.

**INSTITUTO DE PESQUISAS ENERGETICAS E NUCLEARES**  
**NUCLEAR AND ENERGY RESEARCH INSTITUTE**



# **ADVANCED CERAMICS BY FUNCTION**

- 1. ELECTRIC**
- 2. MAGNETIC**
- 3. OPTICAL**
- 4. CHEMICAL**
- 5. THERMAL**
- 6. MECHANICAL**
- 7. BIOLOGICAL**
- 8. NUCLEAR**

# ADVANCED ELECTRIC CERAMICS

## ELECTRIC MATERIALS

### - INSULATION

- IC substrates
- spark plug insulators

### - FERROELECTRIC

- ceramic capacitors

### - SEMICONDUCTOR

- NTC thermistor .....temperature sensor
- PTC thermistor .....heater element
- Varistor .....surge current absorber
- Sintered CdS material..solar cell.
- SiC heater .....electric furnace heater

### - ION CONDUCTING

- solid electrolyte for sodium battery
- Zirconia ceramics.....oxygen sensor, pH meters,  
fuel cells

# ADVANCED CERAMICS ESTIMATE MARKET GROWTH

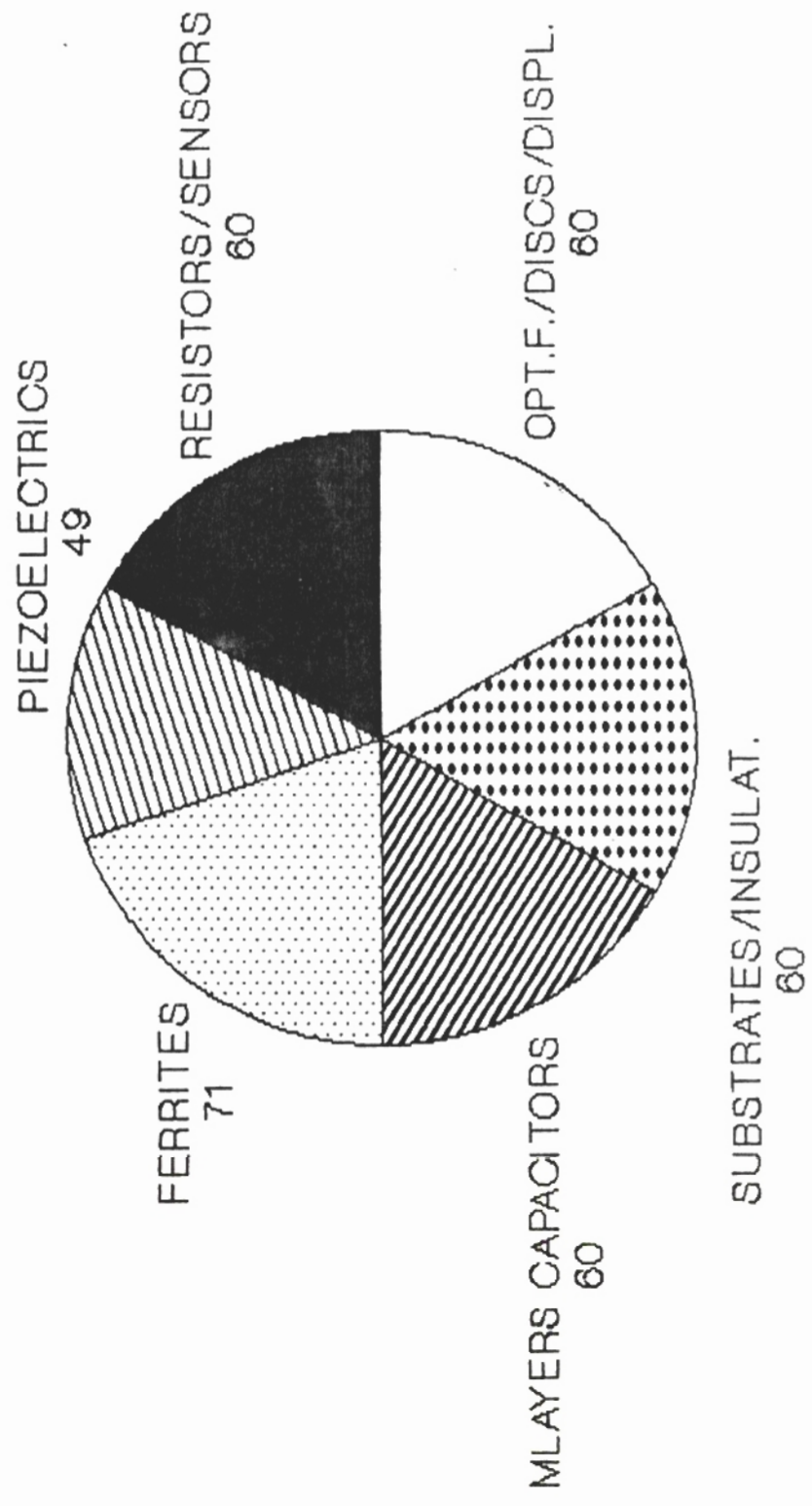
<u>product</u>	<u>year ave. growth</u>
SENSORS-	28 %
STRUCTURAL--	25
CUTTING TOOLS--	20
CAPACITORS-	14
FERRITES, RESISTORS AND	
PIEZOELECTRICS-	14
SUBSTRATES-	10

# ADVANCED CERAMICS

## ESTIMATE WORLD SALES

<u>product</u>	<u>US\$(billion)</u>
SUBSTRATES	1.7
CAPACITORS	1.0
FERRITES	0.9
CUTTING TOOLS	0.8
PIEZOELECTRICS	0.3
STRUCTURAL	0.3
TERMISTORS, VARISTORS	0.2
----- TOTAL	----- 5.2

# ELECTROCERAMICS MARKET



# BRAZILIAN MARKET FOR ELECTRONIC CERAMICS

FUNCTION	COMPONENT	raw materials ton/y	US\$/y (MI)	final product US\$/y (MI)
INSULATORS	sparg plugs	1500	1.5	55
	60 % IC substrates	7.5	0.01	0.6
	resistors	300	0.3	12
FERRO- ELECTRICS	ceramic capacitors	160	1.2	15
	25 % multilayer capacitors	-	4	5 i
				8 i
SEMI- CONDUCTORS	termistors			
	NTC	5	0.35	1
	15 % PTC	2.5	1.4	4
	varistors	24	0.6	12
PIEZO- ELECTRICS	transducers	-	-	-
	oscillators	-	-	-
<b>TOTAL</b>		-	<b>5.8</b>	<b>112.6</b>

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# ADVANCED CERAMICS IN BRAZIL

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## INSTITUTIONS PERFORMING R & D

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### 1. FEDERAL U. OF S. CARLOS, S. PAULO

capacitors  
zirconia sensors  
piezoelectric transducers  
varistors  
substrates  
superconductors

### 2. U. OF S. PAULO STATE, ARARAQUARA, S.P.

piezoelectric transducers  
zinc oxide varistors  
tin oxide sensors  
zirconia

### 3. NUCLEAR AND ENERGY RESEARCH INSTITUTE

zirconia and thoria solid electrolytes  
oxygen sensors  
superconductors

### 4. UNIVERSITY OF S. PAULO, S. PAULO UNIVERSITY OF CAMPINAS, S. PAULO FEDERAL UNIVERSITY OF RIO DE JANEIRO, RJ. FEDERAL UNIVERSITY OF PERNAMBUCO, PE. FEDERAL UNIVERSITY OF PARAIBA, PB.

# PAPERS/ELECTRONIC CERAMICS

## BRAZILIAN CERAMIC SOCIETY

<u>INSTITUTION</u>	<u>1989</u>	<u>1990</u>
U. OF S. PAULO STATE	20	8
FED. U. OF S. CARLOS	19	10
I.P.E.N.	5	5
INDUSTRIES	4	4
OTHERS	11	6
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total	59	33

# **ADVANCED CERAMICS RESEARCH WORK AT IPEN**

## **1. Ceramic powders**

- pure and stabilized zirconia
- aluminum and silicon nitride
- thoria

## **2. Electrical ceramics**

- zirconia and thoria solid electrolytes
- alumina
- superconductors

# **ADVANCED CERAMICS RESEARCH WORK AT IPEN**

## **3. Structural ceramics**

- alumina
- zirconia toughened alumina
- silalons

## **4. Fibers and composites**

- silicon carbide whiskers
- niobium/titanium/zirconia cermets

# **CURRENT RESEARCH ACTIVITIES ELECTRICAL CERAMICS**

## **1. ZIRCONIA AND THORIA-BASED SOLID ELECTROLYTES.**

- sintering aids**
- improvement of electrical performance**
- design of oxygen sensors**
  - \_ steel industry**
  - \_ gas monitoring**

# **CURRENT RESEARCH ACTIVITIES ELECTRICAL CERAMICS**

## **2. ALUMINA**

- electrical resistivity**
  - \_impurity content**
  - \_porosity**
  - \_microstructural evolution**

# **CURRENT RESEARCH ACTIVITIES**

## **ELECTRICAL CERAMICS**

### **3. SUPERCONDUCTORS**

- dc and ac electrical resistivity
- very low field ac magnetic susceptibility
- Y and RE 1-2-3 compounds
- single phase Bi cuprates

# **RESEARCH AT IPEN FACILITIES**

- 1. Labs for chemical analyses**
- 2. X-ray diffractometry**
- 3. SEM, TEM and EMP**
- 4. Ceramographic analyses**
- 5. Electrical measurements  
( LNT - 1300 K )**