Introduction to

Ferro Electronic Materials B.V.

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OUR PRODUCT RANGE

- Powders for ceramic multilayer capacitors
- V-pack for semi-conductors
- Process Temperature Control Rings (PTCR)
- Ceramic tubes

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PROCESS TEMPERATURE CONTROL RINGS

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WHAT IS PTCR?

PTCR is a ceramic device that registers the total amount of heat transferred to it during a firing cycle

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WHY HAS IT BEEN DEVELOPED?

PTCR has been developed to give a better, realistic Representation of the actual firing conditions

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HOW DOES A PTCR WORK?

- PTCR are ceramic rings, which shrink if exposed to heat
- Total heat transferred by convection, conduction and radiation
- The shrinkage is converted into a Ring Temperature, RT
- Conversion is done by using a conversion table, delivered with the product

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WHEN TO APPLY PTCR?

PTCR are applied in following cases:

A. Process control & optimization
B. Trouble shooting
C. Yield improvement
D. Improvement of product quality
E. Reduction of inspection time & costs
F. Quality assurance

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A. PROCESS CONTROL & OPTIMIZATION I

- PTCR for optimal product quality through assessment of thermal performance and characteristics of the kiln
- Assessment of the real performance of the kiln regarding
  - temperature gradients, hot/cold spots
  - kiln settings
  - product and support stacking lay-out
  - influence kiln furniture

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A. PROCESS CONTROL & OPTIMIZATION II

- PTCR are used to monitor the process and ensure the same conditions are met for every run
- No differences between kiln loads
- No differences between kilns

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B. TROUBLE SHOOTING

- Mapping of thermal performance
- Assessment of malfunctioning of parts of the kiln
- Assessment failing thermal elements or thermo-couples

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C. YIELD IMPROVEMENT

- Fine-tuning of the process settings
- Optimization of the energy consumption

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D. IMPROVEMENT OF PRODUCT QUALITY

- By reduction or elimination of differences in thermal performance of parts of the kiln, or between different kilns, the scatter in product quality is reduced
- By optimization of the kiln setting the quality level can be improved

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E. REDUCTION OF INSPECTION TIME & COSTS

Improved processing through the use of PTCR leads to:

- reduction of number of products to be tested
- elimination of product testing is possible
- easy measurement of the ring with the PTCR micrometer
- sampling rate may be reduced to a bare minimum

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F. QUALITY ASSURANCE

PTCR is produced following the international standards following ISO 9001:2000 and 14001

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HOW TO APPLY PTCR I

PTCR are easy to use:

- can be placed at any position in the kiln
- no measurement before usage necessary
- one measurement after use only
- easy conversion of ring diameter into ring temperature
- using a table
- special measuring equipment available

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HOW TO APPLY PTCR II

- no recalibration necessary between different batches
- imprinted batch number allows tractability
- temperature range indicated by colour

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TEMPERATURE CONVERSION TABLE

- Unique conversion of ring diameter into ring temperature
- New table delivered with every new batch
- Batch number clearly indicated on table

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INTERPRETATION OF RING TEMPERATURE

- The ring temperature indicates a total amount of heat applied
- There is an indirect relation to the absolute temperature
- Temperature differences are determined accurately

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DIFFERENT ATMOSPHERES

- PTCR may be applied under different atmospheres:
  - Air
  - Reductive: N2/H2
  - Vacuum
  - Inert: N2
- Under vacuum or reductive conditions, the PTCR LTL, LTH, STL and STH versions have to be prefired for 2 hours at 600°C to burn out the binder
- The RT value measured is influenced by the atmosphere used

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FOR WHOM? THE MARKET ... I

Rough ceramics industry

Traditional:

- building bricks
- paving bricks
- roof tiles
- stoneware pipes

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FOR WHOM? THE MARKET ... II

Fine ceramics industry

Traditional:
- sanitary ware
- porcelain
- earthenware
- refractories
- tiles

Advanced:
- structural ceramics
- electronics ceramics
- ceramic coatings

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WHY PTCR?
A. COST ADVANTAGES I

- **Minimum amount to be required; one ring per measurement point is enough while maintaining reliability; because of an accuracy of 3° RT, PTCR rings ensure the lowest costs**

- **No extra lab costs for re-calibration required; with each batch changement Ferro calibrates their rings**

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WHY PTCR?
A. COST ADVANTAGES II

- PTCR rings are small; minimal transport costs, low stock costs
- Purchase advantages; due to the complete temperature range available in PTCR, the number of suppliers can be reduced

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WHY PTCR?
B. PROFESSIONAL SUPPORT I

- **Qualified and experienced technical engineers; specialized technical staff of engineers have a 30 years experience and knowledge of PTCR which enables us to give professional service**

- **Special application assistance and support; customers' applications can be simulated in our own laboratories which means that problems occuring with special applications of PTCR can be solved quickly and efficiently**

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WHY PTCR?
B. PROFESSIONAL SUPPORT II

- Specialized customer service desk; always accessible for all your questions, correspondence, orders and problems
- Clear documentation; brochures, samples and product information

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WHY PTCR?
C. EASY TO USE I

- Quality is assured; PTCR rings are produced in accordance with ISO-9001:2000 quality standards
- The right ring for the right temperature level; the unique identification of each ring-type ensures correct use
- One single measurement; PTCR measuring equipment is specially designed to simplify a reliable measuring process

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WHY PTCR?
C. EASY TO USE II

- Easy handling; due to their convenient packaging PTCR rings are easy to recognize
- For all type of products; due to their dimensions PTCR rings can be used for every type of industry

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REACTION OF A SATISFIED CUSTOMER I

- After implementation of the PTCR rings in production, we were able to reduce staff in the engineering test lab by 40% and cut overtime drastically .. The result is a sizeable cost saving to us
- Within the first week after implementation of the rings we were able to stop running a kiln, which would have produced scrap products if we would not have had the ring data saying that the previous run had a problem. This quick feedback results in yield improvement for us and better quality products for our customers

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REACTION OF A SATISFIED CUSTOMER II

- There is no question that the rings are very accurate indicators of temperature .. We did reduce our TC testing by about 93%
- We are extremely pleased with the performance of the rings

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FERRO ELECTRONIC MATERIALS B.V.

Founded November 1, 1953
as part of Philips

Since November 2, 1998
Degussa Electronic Materials B.V.

Since January 1, 2000
dmc² Electronic Materials B.V.

Since September 1, 2001
Ferro Electronic Materials B.V.

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TECHNOLOGIES I

Powder preparation technologies:

- **Oxalate process (HPB/X7R grades)**
  - **Capacity: 470 tons/year**
- **Mixed oxide process (Y5V/NPO grades)**
  - **Capacity: 370 tons/year**

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TECHNOLOGIES II

Forming technologies:

- **Extrusion**
- **Rolling**
- **Pressing**

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