

ENVIRONMENTAL BARRIER COATING WORKSHOP

P.P.H. Peronal Power and Heat

November 6-7

Nashville Tennessee

Peter Kuijpers

InnoTech
Europe BV

FORMATEC
technical moulding

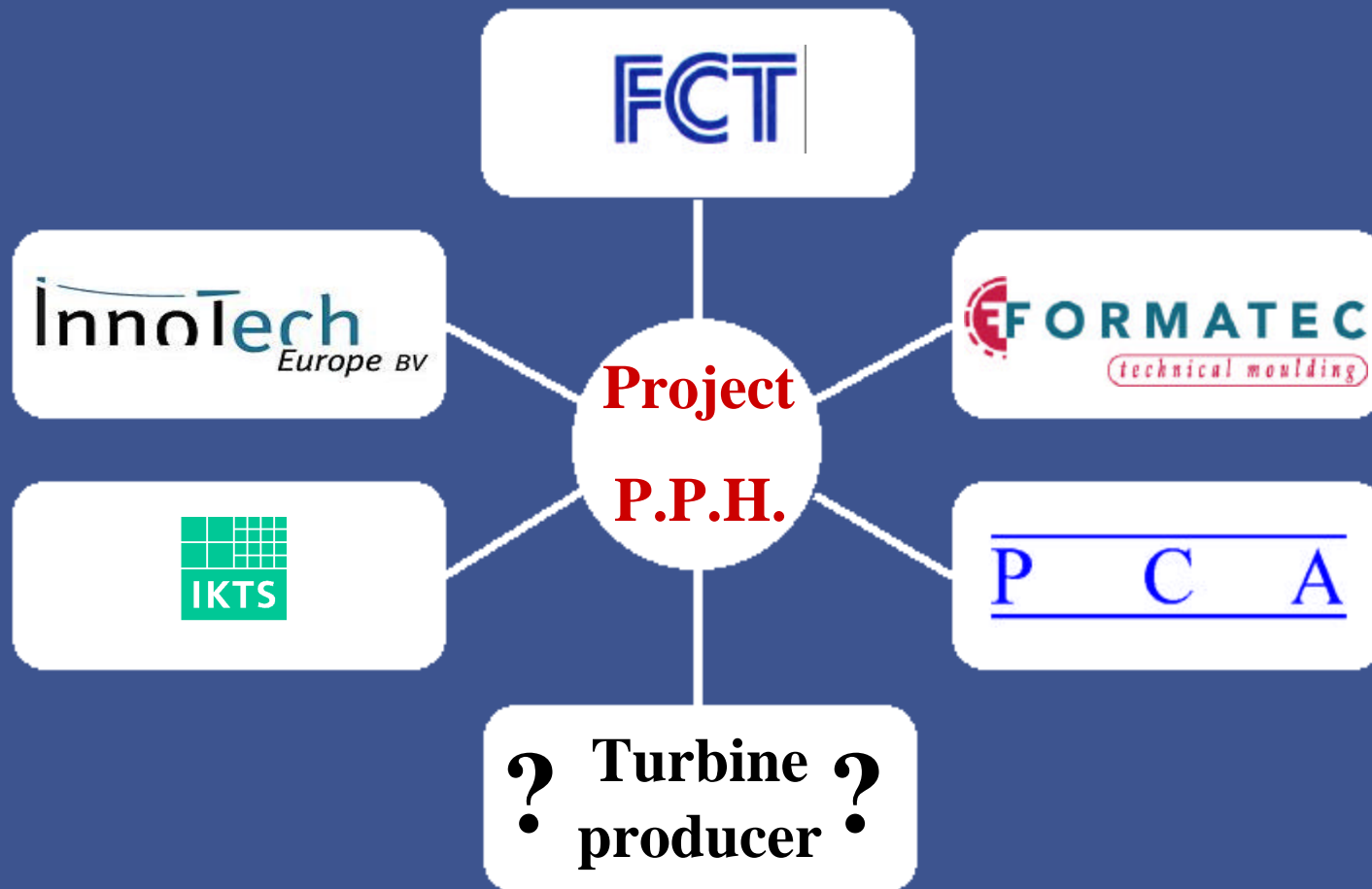
PRESENTATION CONTENTS

1. Project P.P.H
2. Project partners
3. Project status
4. Injection moulding

PROJECT P.P.H. – Personal Power and Heat

1. High efficient 7,5 Kw heat and power unit
2. Injection moulded ceramic hot section
3. Ceramic recuperator and heat exchanger
4. Design based upon high volume production
5. Low unit price

PROJECT PARTNERS



InnoTech Europe B.V.

Innotech Europe B.V.
The Netherlands Europe
www.innotecheurope.nl

Initiator - leader
P.P.H. project



FORMATEC Technical Ceramics b.v.

Formatec Netherlands - Europe

www.formatec.nl

1. Development
2. Toolshop
3. Injection moulding
4. Post finishing



IKTS Germany - Europe

www.ikts.fhg.de

Development and Characterization of Ceramic Materials

- 1. Non-oxide ceramic materials and composites**
- 2. Mechanical properties at ambient temperatures up to 1500° C**
- 3. Long-fiber ceramic matrix composites**
- 4. Long-term oxidation and corrosion**



FCT Technologie GmbH

FCT Germany - Europe

www.kce-fct.de

1. Sintering equipment
2. Development and production

Si₃N₄ parts

3. Powder production



FCT

PCA Engineers Limited

PCA England - Europe

www.pcaeng.uk

1. Cycle studies and optimisation
2. Centrifugal and axial compressor aerodynamic & mechanical design
3. Radial and axial turbine aerodynamic and mechanical design
4. Analysis of component test data
5. Turbomachinery design software



P C A

PROJECT P.P.H. Development Schedule

Task	2002	2003	2004	2005
Start project	■			
Ceramic tests on model turbine	■			
Preliminary design 7,5 Kw turbine	■			
Build first design		■		
Optimization design		■		
Build first design			■	
Final test program			■	
New generation ceramics/coatings	■	■	■	■

INJECTION MOULDING TECHNICAL CERAMICS



1. Ceramic powder + binder

2. Blending

3. Injection moulding

4. Debinding

5. Sintering



VARIOUS POWDERS

Aluminium-oxide

Aluminium-nitride

Zirconium-oxide

Silicon-carbide

Various mixtures



COMPOUNDING



Blending
(ceramic powder and binder)



Granulating

TOOLSHOP

Aluminium moulds

Soft mould (steel)

Surface hardened

Hardened moulds

Multi cavity moulds

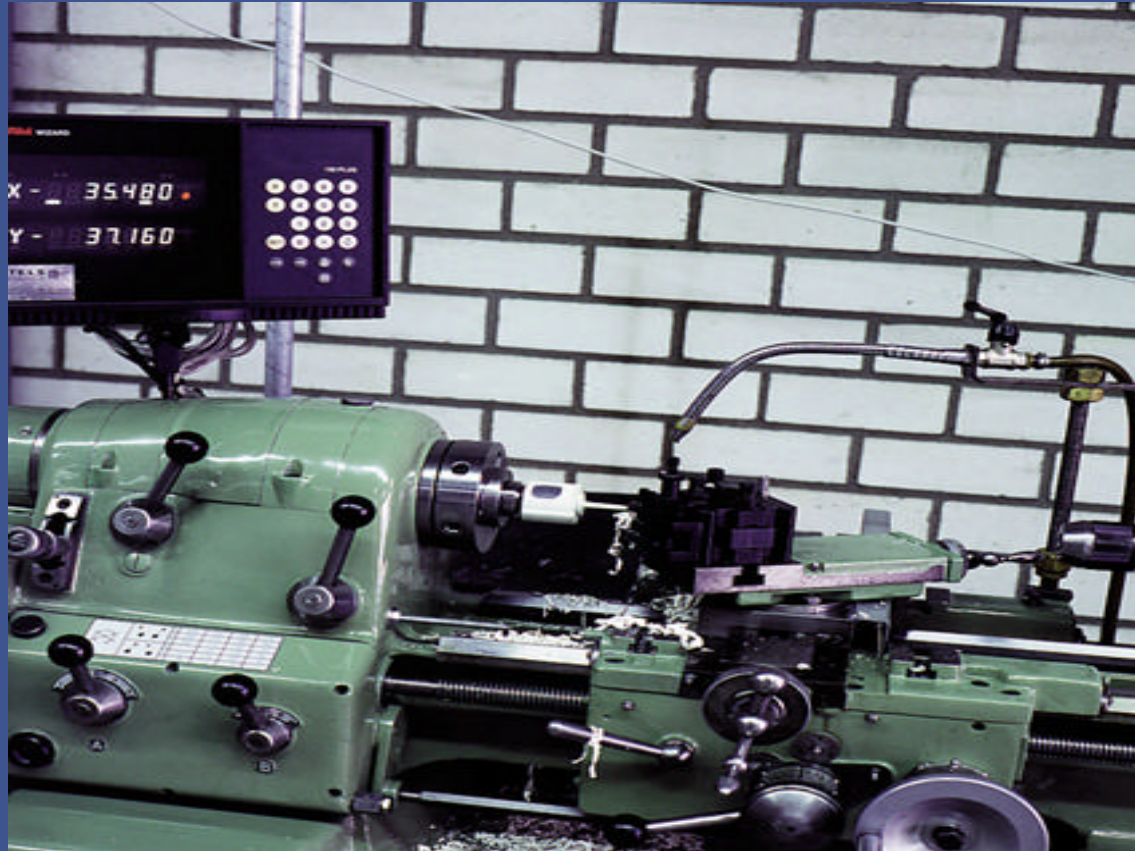


INJECTION MOULDING

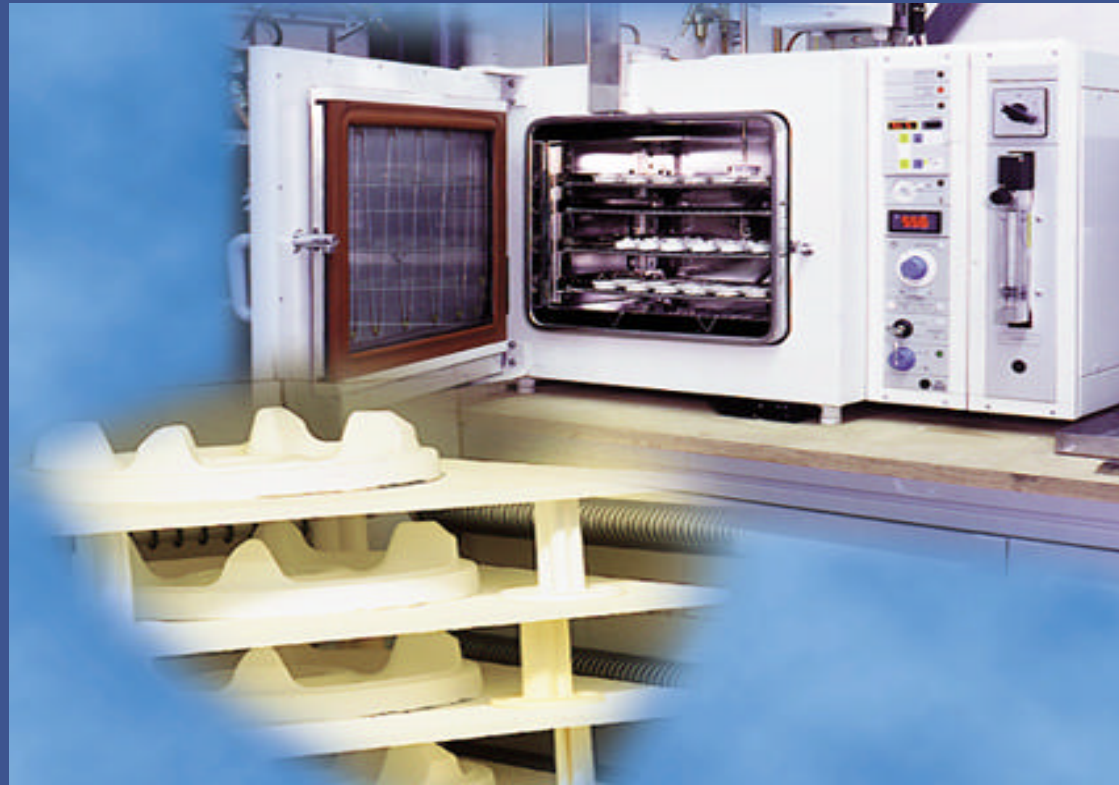


Hardened injection unit
Accurate process control

GREEN MACHINING



DEBINDING



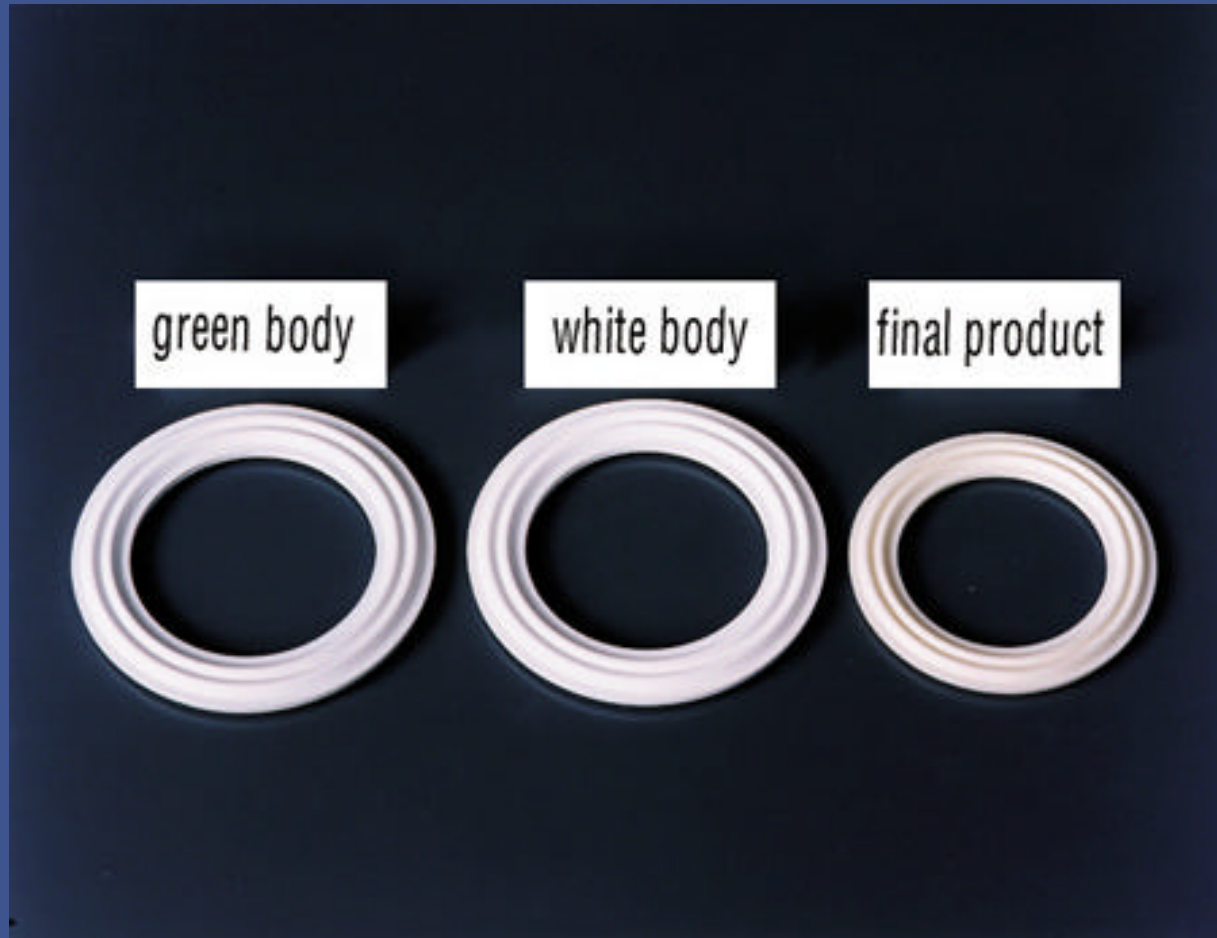
Binder removal
“White body”

SINTERING



Temp. 2200° c
Pressure 100 bar

SHRINKAGE BEHAVIOUR



POST FINISHING

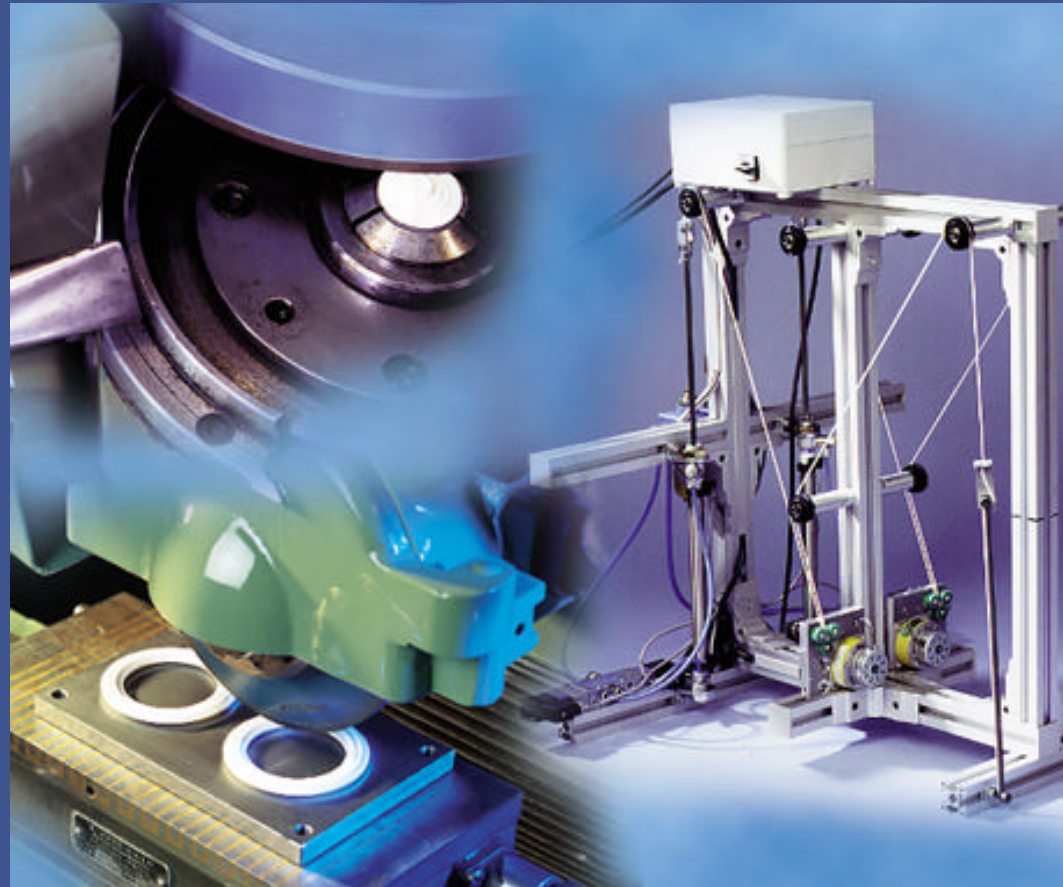
Grinding

Polishing

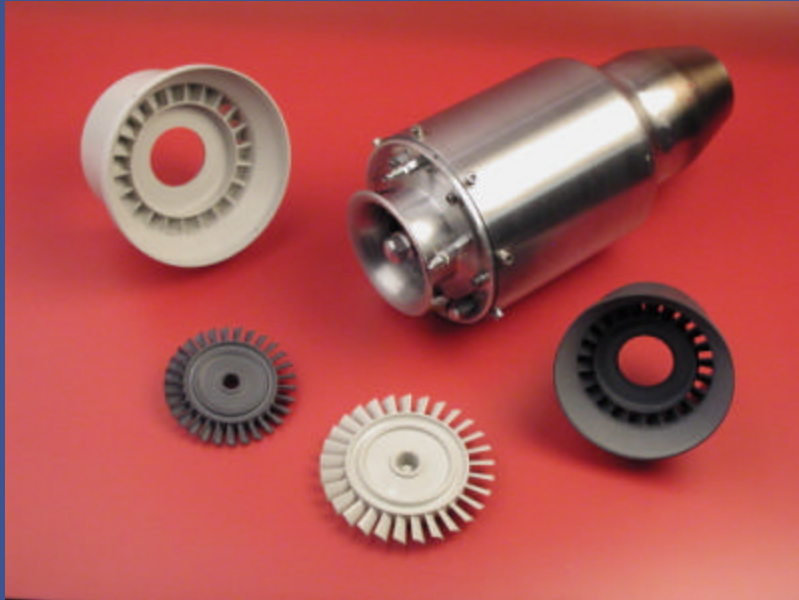
Lapping

Tumbling

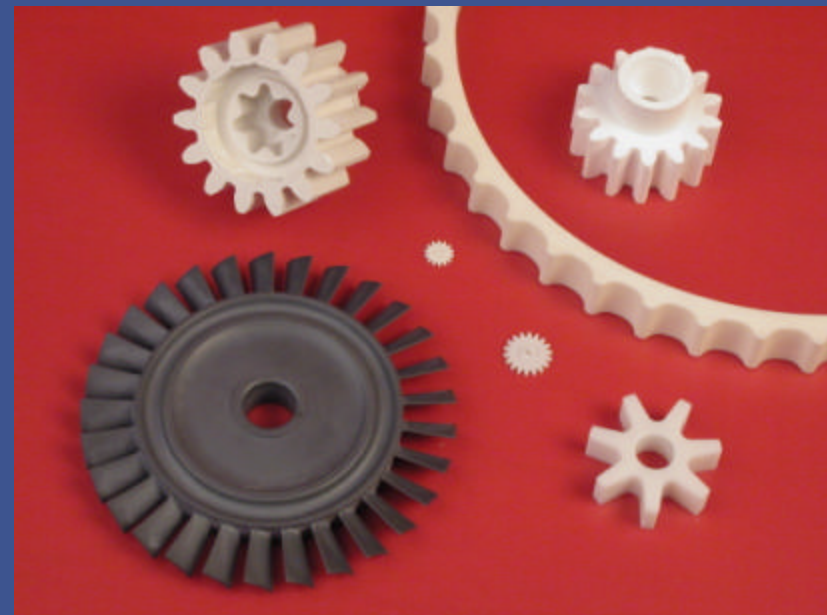
Joining techniques



HIGH TEMPERATURE-RESISTANCE



Gas turbine parts



INJECTION MOULDING TECHNICAL CERAMICS

ADVANTAGE

1. Near netshape technology
2. Complex product shapes
3. Suitable for high volumes
4. Cheap comparing to other techniques

DISADVANTAGES

1. Lower physical properties
2. Expensive moulds

LOOKING FOR CO-OPERATION IN THE USA

1. Microturbine producers
2. Ceramic producers
3. EBC suppliers
4. Institutes