International Town Meeting on SiC/SiC Design and Material Issues for Fusion Systems
Oak Ridge, January 18-19, 2000

SiC_f/SiC CERAMIC MATRIX COMPOSITES (CMC) APPLIED TO NUCLEAR FUSION

DEVELOPMENT STATUS AND MANUFACTURING CAPABILITIES

SNECMA's SiC_f/SiC COMPOSITES DEVELOPMENTS APPLIED TO NUCLEAR FUSION : history and Snecma's contribution

As a world leader in the field of CMC materials, SNECMA has been provided his expertise since 1990 for the development of specific SiCf/SiC composites grades materials tailored to the requirements of nuclear fusion.

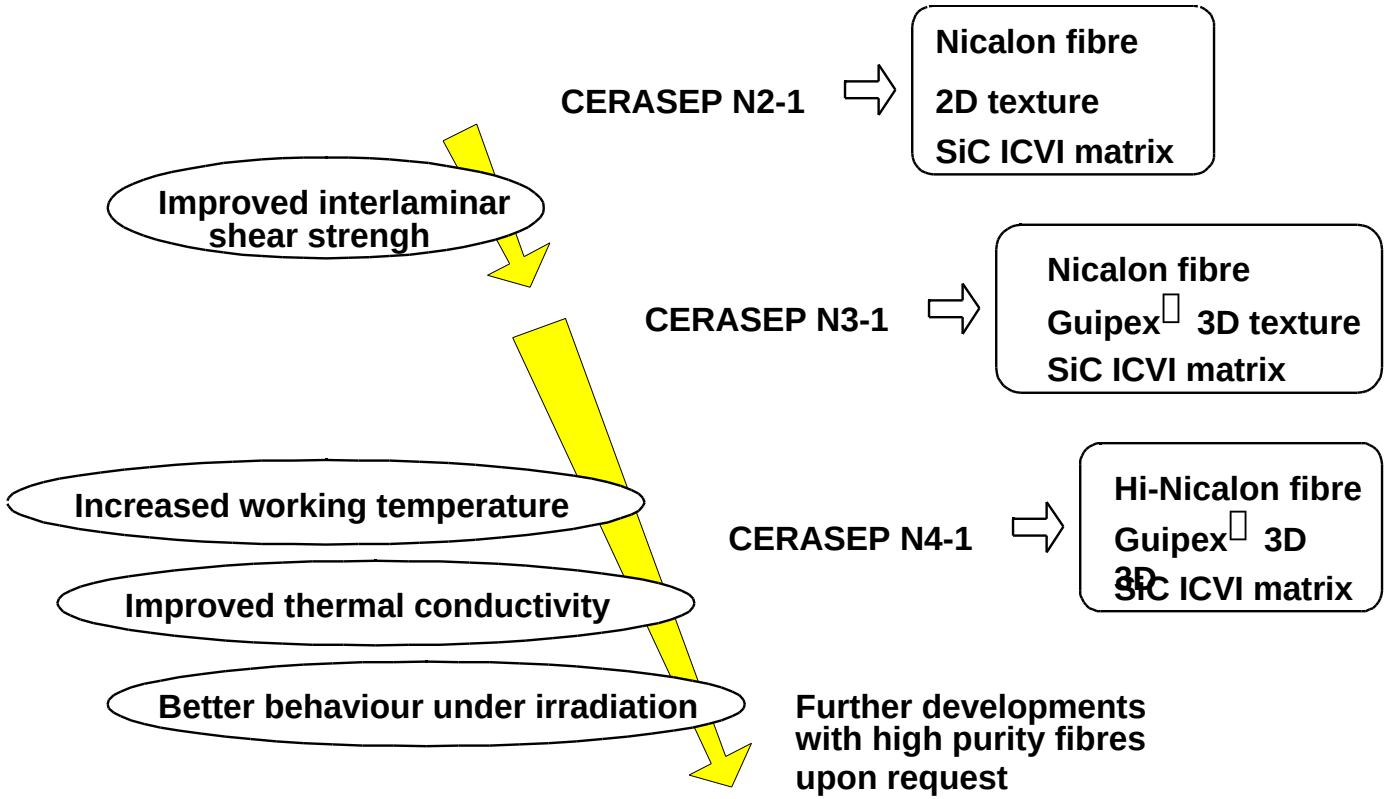
These activities, developed within the European Breeding Blanket Concept for the Fusion Power Reactor Program of the EEC, have led to the development and manufacturing of new SiCf/SiC materials combining a number of attractive properties :

- low activation ;
- good resistance to shocks and heat cycling ;
- high mechanical properties to temperatures of over 1000°C ;
- possibility to manufacture some complex shapes.

SNECMA additionally offers :

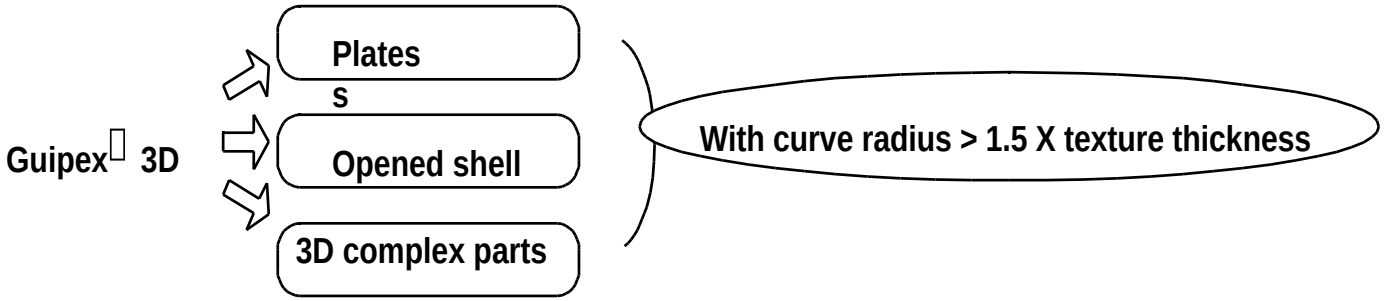
- the largest industrial facilities worldwide for the manufacturing of SiCf/SiC composites parts ;
- a complete assistance in design, modelisation, calculation and high temperature characterisation activities.

SNECMA's SiC_f/SiC COMPOSITES DEVELOPMENTS APPLIED TO NUCLEAR FUSION : OVERVIEW AND PRODUCTS PORTFOLIO.

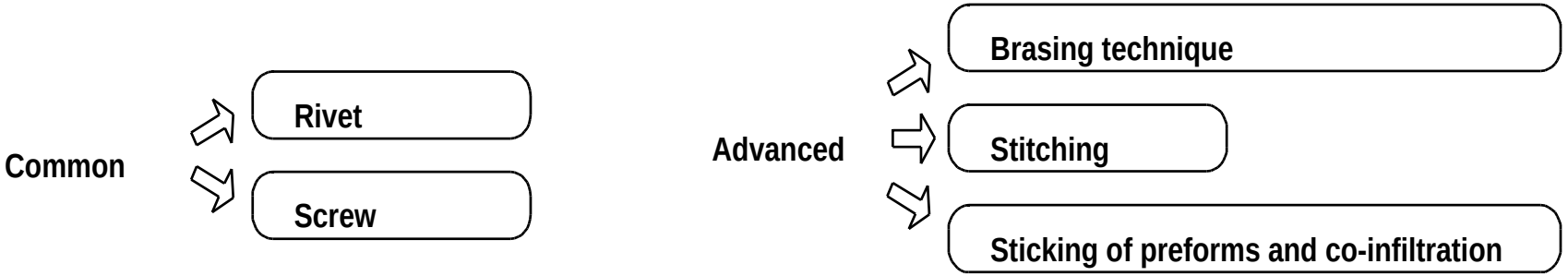


SNECMA's SiC_f/SiC COMPOSITES DEVELOPMENTS APPLIED TO NUCLEAR FUSION : MANUFACTURING CAPABILITIES.

GEOMETRICAL POSSIBILITIES :



LINKS :



SNECMA's SiC_f/SiC COMPOSITES . MANUFACTURING MEANS.

- Full texture manufacturing shops capable of 2D, 3D and 4D textures fabrication.
  Flat panels (width from 500 to 2600mm, length from 500 to 6000mm), cylindrical and conical means (up to 2600mm diameter).

- Largest densification furnaces worldwide (up to 2,5 meters diameter).
  Isothermal Chemical Vapor Infiltration process (SiC and PyC matrix).
  Resin and pitch impregnation units, carbonization furnaces.

- Full integrated design, modelisation, process R&D and composite material expertise enabling the combination of the above industrial means according to applications requirements.

- World leading expertise and facilities in thermo-mecanical characterization.

SNECMA's SiC_f/SiC COMPOSITES DEVELOPMENTS APPLIED TO NUCLEAR FUSION : NEXT FORESEEN DEVELOPMENTS.

Objectives : - improve thermal conductivity ;
- improve the irradiation behavior.

Irradiation behavior : improve the purity of the material.

- Use of new stoechiometric fibers

Thermal conductivity : decrease the porosity of the material.

- New matrix grade embedding siliconization : RSG (Reactive Siliconized Grade), SiC_f/SiC + Si, combining the superior mechanical characteristics provided by the CVI matrix with the good thermal conductivity properties generated by the siliconization.

SNECMA's SiC_f/SiC COMPOSITES APPLIED TO NUCLEAR FUSION : MATERIAL MEASURED PROPERTIES.

	Temperature	CERASEP® N2-1	CERASEP® N3-1
Density	RT	> 2.4 g/cm^3	> 2.4 g/cm^3
Porosity	RT	10 %	10 %
Fibre content	RT	40 %	40 %
Tensile stress (in plane)	RT	285 Mpa	300 Mpa
Tensile strain (in plane)	RT	0.75 %	0.80 %
Tensile modulus (in plane)	RT	200 Mpa	200 Mpa
Translaminar shear stress	RT	200 Mpa	200 Mpa
Thermal conductivity (through thickness)	RT 800°C 1000°C	9 W/m.K 5.8 W/m.K 5.7 W/m.K	13 W/m.K 7.6 W/m.K 7.5 W/m.K
CTE (in plane)	1000°C	$4.10^{-6}/K$	$4.10^{-6}/K$

Note : CERASEPâ N4-1, including Hi-Nicalon fibres, is not caracterized yet. Samples produced in 1999.