**A Brief Write-up with Photo on**
**Technology for Fused Silica Ceramic Cores Used for Making Hollow Nickel-Base Superalloy Cast Parts of Aero Gas Turbine Engines**

## 1. Description of Technology

Nickel-base superalloy parts such as blades, vanes and rotors are used in hot sections of aero gas turbine engines. These parts are often hollow and contain serpentine internal cooling channels which are difficult to be generated through machining. These channels are typically formed by utilizing one or more appropriate ceramic cores in the investment cast parts. The embedded ceramic cores are then removed by mechanical or chemical methods. After their removal, an internal cooling channel having the same dimensions and shape of the ceramic core is left behind inside the component. For achieving the required cooling channel configuration in the cast components, the ceramic core must have sufficient strength to withstand wax injection pressure during pattern making as well as metallostatic pressure during casting. It must be also be dimensionally and chemically stable up to casting temperature and impart suitable surface finish to the channel walls after casting operation. In addition to these attributes, the core must also be easily removable without affecting the cast metal part. The choice for material for core making is very limited due to the above requirements. Fused silica based ceramic core materials have been found suitable for investment cast superalloy parts.

DMRL has developed the technology of silica core making through ceramic injection moulding (CIM) process. This process is suitable for production of complex ceramic cores in large numbers. In this process, ceramic powder is mixed with polymeric binders, plastisizer and lubricants to get CIM feedstock. Then feedstock is injected into die cavity at a high pressure using CIM machine to get green ceramic core. The green cores are then debindered and sintered to get the desired properties. The dimensional compliance of DMRL-developed cores is within ±0.3 mm.

DMRL has developed following capabilities as a part of ceramic core technology.

a) Designing of ceramic core die suitable for CIM. DMRL can design die blocks, fixtures, setter gauges etc from component drawing.
b) DMRL has developed indigenous vendors for machinery and tools for production of ceramic cores like sigma mixer, ceramic injection moulding machine and top hat furnace etc.
c) CIM feedstock formulation and preparation methodologies
d) CIM and sintering techniques of green cores
e) Quality control and inspection technique for ceramic feedstock and sintered ceramic cores
f) Removals of ceramic cores from investment cast metal parts by caustic leaching process

## 2. Application Areas

It can be used in aerospace, industrial, healthcare, sports and automotive sectors.

## 3. USP of the Technology

DMRL technology can be used for producing high precision complex ceramic cores needed for aero engine components such as blades and vanes. This technology is currently unavailable with any indigenous source. DMRL's technology has been tested for its reliability and consistency in producing high quality ceramic cores.

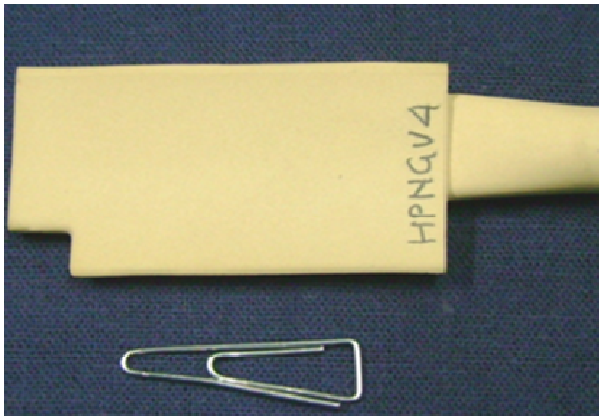


*Fig. 1: High pressure nozzle guide vane (HPNGV) core.*

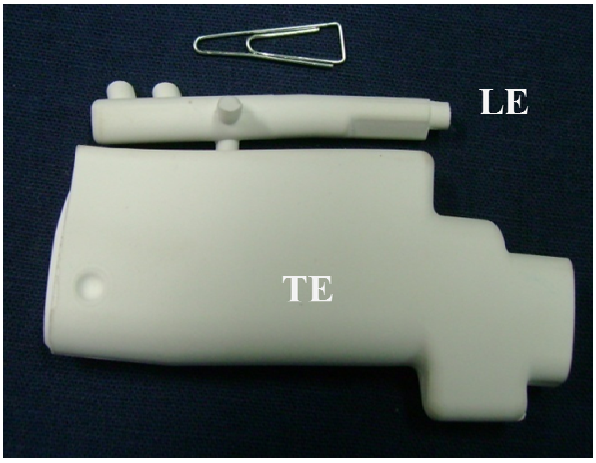


*Fig. 2: Low pressure nozzle guide vane (LPNGV) core.*

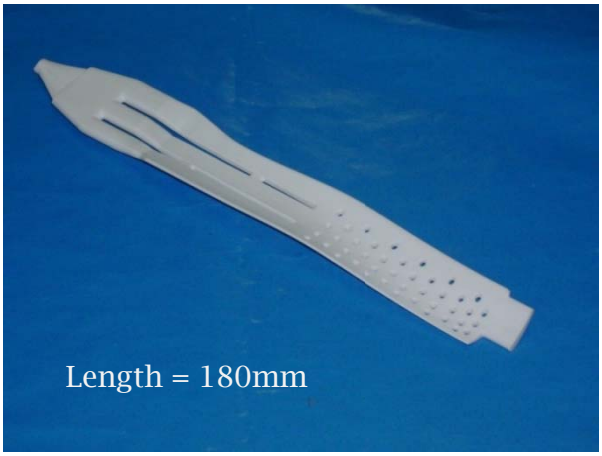


*Fig. 3: Shrouded low pressure turbine blade (LPTB) core.*