Single Crystal blades by DRDO

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In News: Recently, Defence Research and Development Organisation (DRDO) has developed single crystal blades technology and supplied 60 of these blades to Hindustan Aeronautics Limited (HAL) as part of their indigenous helicopter development program for helicopter engine application.

About Single Crystal blades by DRDO

- It is part of a program taken up by Defence Metallurgical Research Laboratory (DMRL), a premium laboratory of DRDO, to develop five sets (300 in number) of single crystal high pressure turbine (HPT) blades using a nickel-based super alloy.
- The supply of the remaining four sets will be completed in due course.
- The DMRL undertook this task based on its expertise gained during the development of such a technology for an aero-engine project earlier.
- Complete vacuum investment casting process to realise the blades, including die design, wax pattering, ceramic moulding, actual casting of components non-destructive evaluation (NDE), heat treatment and dimensional measurement, has been established at DMRL.
- Special ceramic composition had to be formulated for making strong ceramic moulds which can withstand metallostatic pressure of liquid CMSX-4 alloy at 1500°C and above during casting operation.
- The challenge of maintaining the required temperature gradient has also been overcome by optimising the casting parameters.
- A multi-step vacuum solutionizing heat treatment schedule for complex CMSX-4 superalloy to achieve the required microstructure and mechanical properties has

also been established.

- Further, a stringent non-destructive evaluation (NDE) methodology for the blades along with the technique for determining their crystallographic orientations has been developed.

Significance of Single Crystal blades

- Helicopters used in strategic and defence applications need compact and powerful aero-engines for their reliable operation at extreme conditions.
- To achieve this, state-of-the-art Single Crystal Blades having complex shape and geometry, manufactured out of Nickel based superalloys capable of withstanding high temperatures of operation are used.
- Very few countries in the world such as the USA, UK, France and Russia have the capability to design and manufacture such Single Crystal (SX) components.