Isothermal M vs. H data obtained at different temperatures using a commercial SQUID magnetometer. ΔS_m is calculated from the M-H curves using the formula,

$$\Delta S_m = \int_0^H \left[\frac{\partial M}{\partial T}\right]_H dH$$

ΔS_m is found to be positive across the first order antiferromagnetic to ferromagnetic transition (with rising T) observed in the present Ru doped $CeFe_2$ pseudo-binaries. This tells that if a magnetic field is applied adiabatically across the FOPT in the present series of alloys, the sample would undergo a reduction in temperature. On the other hand, ΔS_m is found to be negative across the second order ferromagnetic to paramagnetic transition (with rising T). The samples would therefore produce cooling during adiabatic withdrawal of magnetic field at various starting T across the second order transition. The largest magnitude of ΔS_m in the whole series of Ru doped $CeFe_2$ measured is found to be 7.16 J per kg per K, in $Ce(Fe_{0.96}Ru_{0.04})_2$, at about 60K, i.e., across the FOPT. The largest magnitude of ΔS_m across the second order transition is observed in undoped $CeFe_2$, which does not exhibit an FOPT. ΔS_m across the second order transition appears to decrease in magnitude with Ru doping. Further studies on the present series of alloys towards the quantitative estimation of adiabatic temperature changes with changing applied magnetic fields and the refrigeration capacity of the alloys in different temperature regimes is presently in progress. These along with the parallel studies on Gd_5Ge_4 being carried out in LTPL, are expected to provide substantial information in the direction of designing suitable working materials for energy efficient and environment friendly refrigerators.

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L.4 Laser rapid manufacturing of colmonoy-6 bushes

Colmonoy bushes are used as guiding material in many components of Prototype Fast Breeder Reactor (PFBR). Traditionally, these bushes are made by conventional casting process. However, the indigenous non-availability of cast bushes and prohibitive cost of imported bushes necessitated the development of alternative process for their fabrications. At present, these bushes are fabricated by depositing the hard facing alloy on austenitic stainless steel rods using Gas Tungsten Arc Welding (GTAW) process followed by precision machining. However, this process is cumbersome and time consuming, as it involves many steps of conventional processing, viz. welding, machining, grinding, etc. Therefore, another process is developed using Laser Rapid Manufacturing (LRM).

LRM is the process of fabricating near net shape three-dimensional components, directly from CAD model, by multi-layer overlapped laser cladding. Using a 10 kW CW CO_2 Laser system, integrated with co-axial powder feeding unit and 3-axis laser workstation, Colmonoy-6 bushes were fabricated with this technique. The Colmonoy alloy normally has very poor cracking resistance. However, cracks were avoided by processing at an elevated temperature (673 K) and subsequent controlled cooling.

***Fig. L.4.1** Different stages showing laser rapid manufacturing of Colmonoy bush*

The LRM fabricated bushes are then machined using Cubic Boron Nitride (CBN) tools to achieve desired dimensional tolerance of H7/h6 grade and surface finish of 0.4 micron. Testing of these bushes by various characterization techniques e.g. dye-penetrate test, Ultra-sonography, micro hardness, metallographic examination, ageing experiments for 24 hours etc., confirmed their quality at par with those made by GTAW technique.

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L.5 Enhancement of intergranular corrosion resistance of 316(N) weld metal by laser surface resolidification

AISI type 316LN stainless steel (SS) has been developed indigenously as main structural material for 500 MWe Prototype Fast Breeder Reactor (PFBR) at Kalpakkam. Welding of type 316LN SS is to be carried out with modified