A.15: Very large refrigerant capacity at room temperature and modeling the hysteretic response in Fe-Rh based alloys.

The Fe-Rh based alloy system is an interesting system which shows giant magnetocaloric effect (change in temperature by the adiabatic application or removal of magnetic field), giant elastocaloric effect (change in temperature by applying stress) giant magnetostriction (change in volume by application of magnetic field) and giant magnetoresistance (change in electrical resistance due to application of magnetic field), occurring close to room temperature. Such wide range of functionality in this alloy system arises due to a first order magneto-structural transition (FOMST) from an antiferromagnetic to ferromagnetic state which takes place both as a function of temperature and magnetic field. The work at the Magnetic and Superconducting Materials Section of MAASD on this alloy system and our ongoing research on various other functional materials has shown that the understanding of thermomagnetic history and memory effects across disorder influenced first order phase transitions is vital if such materials are to be used for reproducible technological applications.

In this news item, we present the results of magnetocaloric effect measurements in one of the Fe-Rh based alloys, namely $Fe_{0.975}Ni_{0.025}Rh$, and linear strain as a function of temperature in another alloy which is $Fe_{0.955}Ni_{0.045}Rh$. Both these alloys undergo a FOMST from an antiferromagnetic to ferromagnetic state. Figure A.15.1 shows the change in entropy as a function of temperature in $Fe_{0.975}Ni_{0.025}Rh$ for a field excursion of 5 T.

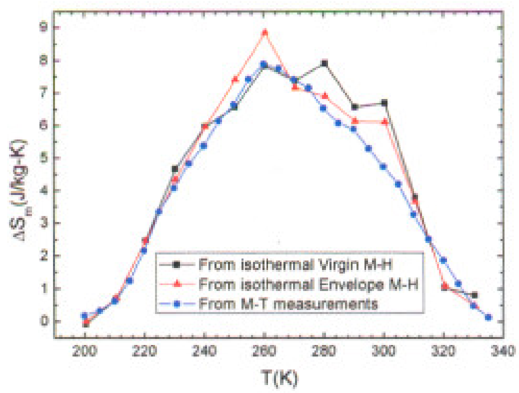

Fig. A.15.1: The temperature dependent magnetocaloric effect in $Fe_{0.975}Ni_{0.025}Rh$ for a field excursion of 5 T

The refrigeration capacity (RC), is estimated by calculating the area under the temperature dependent entropy curve with the hot and cold ends at half the maximum value of the entropy. The hysteresis loss is subtracted to get the effective refrigeration capacity (RC_{eff}). The RC_{eff} for our material is about 492.8 J/kg for a field excursion of 5 T, with the hot end at 307 K and the cold end at 230.5 K. This is the largest value of RC_{eff} achieved so far at room temperature for any material worldwide.

Figure A.15.2 shows the results of modeling the hysteretic behaviour in linear strain in $Fe_{0.955}Ni_{0.045}Rh$. The minor hysteresis loops are modeled by assuming that each microscopic location of the sample has its own transition temperature and hysteresis, and the complete hysteresis curve is a total of all these individual hystereses. This picture is similar to a *landscape*, i.e the ups and downs in the transition parameters as a function of spatial coordinates look like hills and valleys. These results can be used to predict the behaviour of the material undergoing multiple temperature cycles.

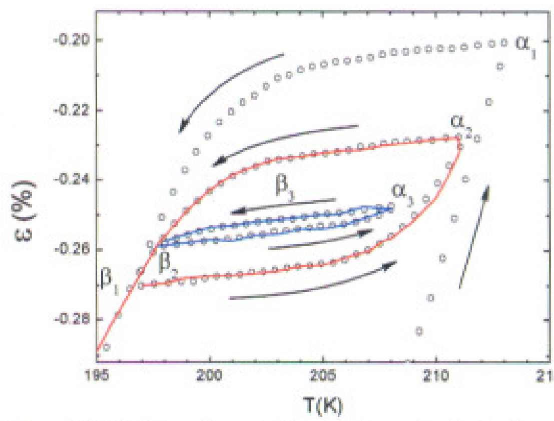

Fig. A.15.2: Experimental data (open circles) along with the modeled curve (solid lines) in $Fe_{0.955}Ni_{0.045}Rh$.

In summary, we have achieved a very large refrigeration capacity of about 492.8 J/kg at room temperature in $Fe_{0.975}Ni_{0.025}Rh$, which is the largest so far in this temperature range for any material worldwide. We have also modeled the hysteretic behavior of the giant magneto-strictive material $Fe_{0.955}Ni_{0.045}Rh$ which is exposed to multiple temperature cycles. Our results highlight the need for understanding the phenomenon of disorder influenced first order transition and the related thermomagnetic history effects, for achieving reproducible behaviour under multiple cycles of field and temperature.

These results are published in *J. Phys. D.: App. Phys.*, Vol. 44, p. 242001, (2011) and *J. Phys.: Condensed Matter.*, Vol. 24, p. 216004, (2012), which can be referred for further details.

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