# Giant Magnetocaloric Effect in Composites based on Polymeric matrix and Manganese Arsenide

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The polymer matrix composites with MnAs powder as reinforcing material were obtained. The magnetocaloric effect (MCE) was study for MnAs polymeric composite and MnAs alloy. The influence of composite preparation process on the MCE was studied. Ones is to study MCE dependence on the magnetic texture of composite. Second is an influence of MCE on the magnetoactive material grain sizes. The composite with micro- and nanosizes grains were obtained. Other is the hydrostatic pressure application during moulding. It was established that the optimum properties, such as giant MCE and low temperature hysteresis, are found in composite with 1$\mu$m particles and polyvinyl acetate matrix hardened at pressure of 10 kBar.

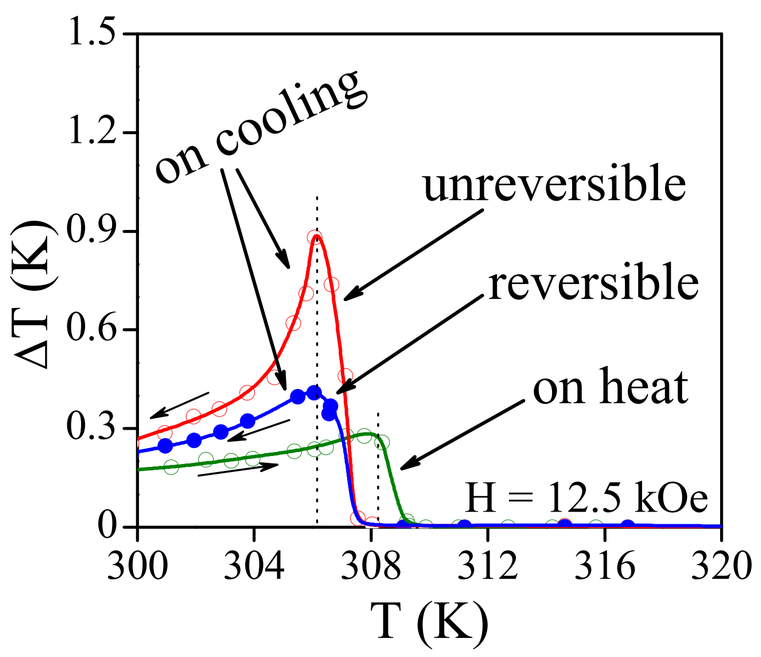
A composite material is a multi-phase system consisted of matrix material and reinforcing material. The composite not only retains the key feature of the original component materials, but also gets the performances that are not depicted by the original components through the combined effects. Various functional materials can be produced by compounding different materials of function.

The MnAs is a ferromagnetic with first order phase transition in both magnetic and structural subsystem near room temperature. The temperature dependence of the MnAs MCE shows a wide hysteresis which blocks of its application.

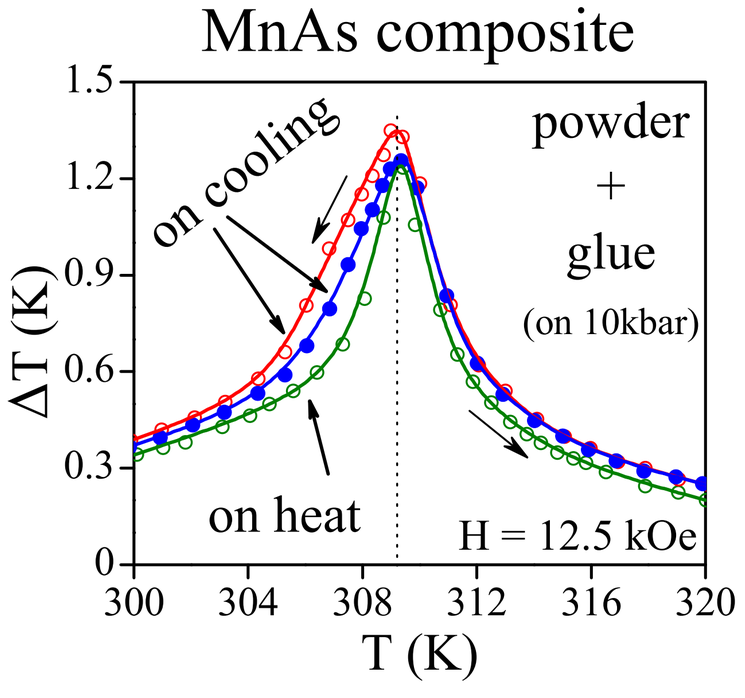
The aim of this work is to investigate the influence of both polymeric matrix type and processing methods of composite to the temperature behavior of magnetocaloric effect (MCE) and finding the dependence of MCE and unstable magnetic condition to be produced by thermal and magnetic history of sample.

The composites were prepared from nano- and microsrystalline metallic powder fixed in polymeric matrix; the volume of polymer is less than 8%. There were obtained both textured by magnetic field and isotropic samples fixed by hydrostatic pressure up to 20 kbar.

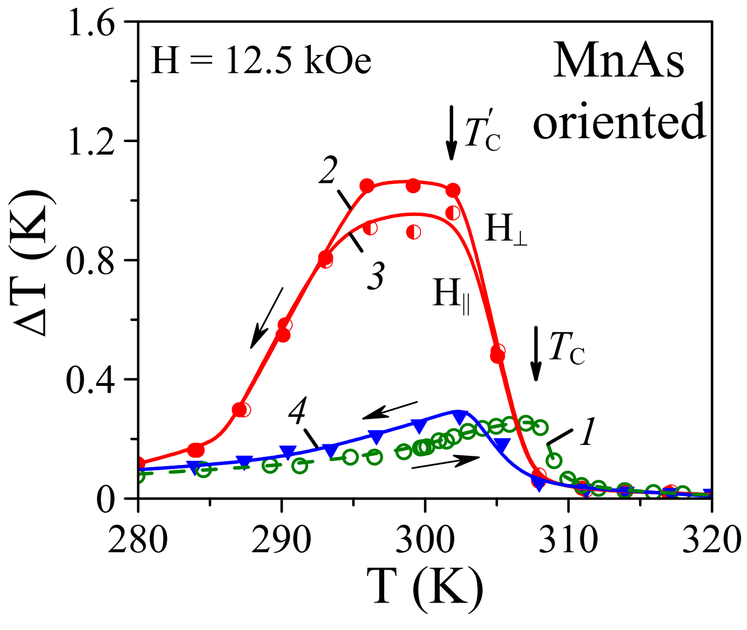
A bulk MnAs demonstrates a strong temperature and field hysteresis of magnetic properties. The MCE of MnAs on heating in magnetic field 12.5 kOe reaches a magnitude $\Delta T$= 0.28 K at temperature $T_C$ = 308 K. Where sample is cooled from paramagnetic state ($T > 320$ K) to room temperature, the MCE shows larger value $\Delta T$= 0.88 K at $T'_C$ = 306 K.



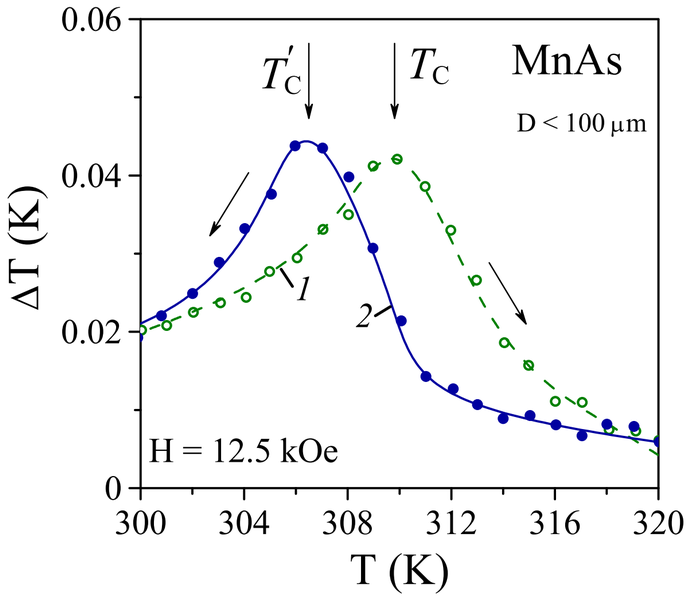

It is established that the optimum properties, such as giant MCE and low temperature hysteresis, are found in composite with 1 m particles and polyvinyl acetate matrix hardened at pressure of 10 kBar. The maximum of MCE in this composite is $\Delta T \sim 1.3$ K (at 309 K) in 10 kOe. These properties are caused by the residual pressure of polymer mould on grains.




It can be conclude, that in composite aligned by magnetic field demonstrates an increasing a temperature hysteresis of MCE in compare with MnAs single crystal, while the value of reversible MCE at heating and cooling increase in this composite. The maxima of MCE at the heating $\Delta T$ = 0.3 K at $T_C$ = 309 K. At cooling the MCE demonstrate a broad maximum in range 296-302 K with $\Delta T$ = 1 K. It is irreversible MCE.




The decreasing of grains size less than 1 $\mu$m leads to reduction of the composite's MCE. Here, on both cases the value of MCE is less than $\Delta T$ = 0.05 K. So, the decreasing of grain size of magnetoactive material less that 1 $\mu$m leads to strong decrease of the MCE. The temperatures of the MCE maximum on cooling $T'_C$ = 306 K and on heating $T_C$ = 309 K. So, the temperature hysteresis of MCE preserves in submicron composite.




- It was shown, that the decreasing of grain size less than 1 $\mu$m leads to reduction of the MCE in nanosized composites.
- It was found, that both the hysteresis and maximum value of MCE are increased in textured composites in compare with bulk MnAs.
- It is established that the optimum properties, such as giant MCE and low temperature hysteresis, are found in composite with 1$\mu$m particles and polyvinyl acetate matrix hardened at pressure of 10 kBar. The maximum of MCE in this composite is $\Delta T \sim$ 1.3 K (at 309 K) in 12.5 kOe. At the same time the temperature hysteresis of MCE is depressed. These properties are caused by the residual pressure of polymer mould on grains.

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