ExpertRating
An ISO 9001:2000 Company
NANOTECHNOLOGY IN-CONTEXT

News By Subject

Chemistry & Physics

Key: Meeting | Journal | Funder

Chinese Science Bulletin

Ferromagnetism at 230 K found in a new diluted magnetic semiconductor by Chinese physicists

Diluted magnetic semiconductors (DMS) have received much attention due to their potential application in spintronics. One of the challenges to possible application for DMS is approaching Tc near room temperature. Now scientists at the Institute of Physics in Beijing report in the Chinese Science Bulletin a new diluted ferromagnetic semiconductor.

National Natural Science Foundation of China, Ministry of Science and Technology of China

Contact: Changqing Jin
jin@iphy.ac.cn
Science China Press

Nature Communications

Speeding up data storage by a thousand times with 'spin current'

The storage capacity of hard drives is increasing explosively, but the speed with which all that data can be written has reached its limits. Researchers at Eindhoven University of Technology and the FOM Foundation present a promising new technology which potentially allows data to be stored 1,000 times as fast in Nature Communications on 10 July. The technology, in which ultra-short laser pulses generate a 'spin current,' also opens the way to future optical computer chips.

FOM Foundation

Contact: Barry van der Meer
b.v.d.meer@tue.nl
31-628-783-207
Eindhoven University of Technology

Science

International science team solve biological mystery

The debate over whether a single hydrogen atom exists is finally settled.

Leverhulme Trust, Biotechnology and Biological Sciences Research Council, Wellcome Trust, Bruker UK Ltd., European Union, Institut Laue-Langevin, Heinz Maier-Leibnitz Zentrum

Contact: Ellen Rudge
er134@le.ac.uk
University of Leicester

PUBLIC RELEASE DATE: 10-Jul-2014

Contact: Changqing Jin
jin@iphy.ac.cn
Science China Press

Ferromagnetism at 230 K found in a new diluted magnetic semiconductor by Chinese physicists

Diluted magnetic semiconductors (DMS) have received much attention due to their potential application in spintronics, or the storage and transfer of information by using an electron's spin state, its magnetic moment and its charge.

In typical systems based on III-V semiconductors, such as (Ga,Mn)As, (In,Mn)As or (Ga,Mn)N, substitution of divalent Mn atoms into trivalent Ga (or In) sites leads to severely limited chemical solubility, resulting in metastable specimens only available as epitaxial thin films. The hetero-valence substitution, which simultaneously dopes both charges and spin, makes it difficult to individually control each quantum freedom.

Recently a group led by Professor Changqing Jin at the Institute of Physics, part of the Chinese Academy of Sciences, in Beijing, collaborated with scholar Y.J. Uemura at Columbia University in the discovery of a new DMS of bulk Li(Zn,Mn)As (termed "111" following the chemical compositions ration), where isovalent (Zn,Mn) spin doping was separated from charge control via Li concentrations, showing a Curie temperature up to Tc = 50K (Z. Den et al. *Nature Communications* 2, 422 (2011)).

Compared with classical diluted magnetic semiconductors such as (Ga,Mn)As, the lower Tc of the new "111" system is an obstacle for possible application.

More recently, a new ferromagnetic DMS (Ba,K)(Zn,Mn)2As2 (named "122" type following the chemical ration) system sharing the same structure with "122" type iron pnictide superconductors was reported. Via (Ba,K) substitution to dope hole carriers and (Zn,Mn) substitution to supply magnetic moments, the systems with 5-15% Mn doping exhibit ferromagnetic order with Tc up to 180 K (K. Zhao et al. *NATURE COMMUNICATIONS* |4: 1442 (2013)). The ferromagnetic order, developing in the entire volume as indicated by SR results, is evidenced by the anomalous Hall effect in the ferromagnetic states.

One of the challenges to possible application for DMS is approaching Tc near room temperature. Given the fact that the Curie temperature of (Ga,Mn)As could be highly enhanced through increasing carrier density by low temperature annealing, optimizing synthesis condition may also pave the way toward further improving Tc in the (Ba,K)(Zn,Mn)2As2 system as well. To avoid the volatility of K at high temperature, and to increase K contents in the sample and consequently increase carrier density, the mixture was heated under 650°C for 60h, a hundred degrees lower than the boiling temperature of the element potassium. This enhanced ferromagnetism with Tc at 230 K in (Ba0.7K0.3)(Zn0.85Mn0.15)2As2 DMS, which is higher than the record Tc of 200 K for (Ga,Mn)As.

The (Ba0.7K0.3)(Zn0.85Mn0.15)2As2 DMS shows spontaneous magnetization following T3/2 dependence expected for a homogeneous ferromagnet with saturation moment 1.0μB for each Mn atom.

As indicated, the carrier mediated and RKKY like interaction induced ferromagnetism could also be observed in insulating samples close to the metal-insulator transition. The resistivity curve of (Ba0.7K0.3)(Zn0.85Mn0.15)2As2, similar to that of (Ga,Mn)N, exhibits a small increase at low temperatures, due presumably to spin scattering of carriers caused by Mn dopants. Clear signature of the ferromagnetic order is evidenced by the obvious negative magnetoresistance below Tc, which is greatly enhanced during decreasing temperature. At T=10K, an obvious hysteresis is observed in the magnetoresistance curve, showing a consistent coercive force in the M(H) curve.

In the present "122'' DMS ferromagnet (Ba0.7K0.3)(Zn0.85Mn0.15)2As2, semiconducting BaZn2As2, antiferromagnetic BaMn2As2, and superconducting (Ba,K)Fe2As2 all share the same crystal structure, with quite good lattice matching in the a-b plane (mismatch=3%). These could provide distinct advantages in attempts to generate new functional devices based on junctions of various combinations of the aforementioned DMS, superconductor, and magnetic states.

###

"The new DMS with decoupled spin charge doping mechanism would be promising to develop brand new spintronics," report scientists Kan Zhao, Bijuan Chen, Guoqiang Zhao, Zhen Yuan, Qingqing Liu, Zheng Deng, Jinlong Zhu and Changqing Jin, all of the Institute of Physics in Beijing, in an article titled "Ferromagnetism at 230 K in (Ba0.7K0.3)(Zn0.85Mn0.15)2As2 diluted magnetic semiconductor," published in the *Chinese Science Bulletin*.

This work received funding from the National Natural Science Foundation of China and the Ministry of Science and Technology of China.

See the article:

Kan Zhao, Bijuan Chen, Guoqiang Zhao, Zhen Yuan, Qingqing Liu, Zheng Deng, Jinlong Zhu, Changqing Jin, "Ferromagnetism at 230 K in (Ba0.7K0.3)(Zn0.85Mn0.15)2As2 diluted magnetic semiconductor," *Chin. Sci. Bull*. (2014) 59(21):2524–2527.

This article was published online in the *Chinese Science Bulletin* by Science China Press and Springer-Verlag Berlin Heidelberg.

Science China Press is a leading publisher of scientific journals in China, and operates under the auspices of the Chinese Academy of Sciences. Science China Press presents to the world leading-edge advancements made by Chinese scientists across a spectrum of fields. http://www.scichina.com/

AAAS and EurekAlert! are not responsible for the accuracy of news releases posted to EurekAlert! by contributing institutions or for the use of any information through the EurekAlert! system.

HOME DISCLAIMER PRIVACY POLICY TERMS & CONDITIONS CONTACT US TOP
Copyright ©2014 by AAAS, the science society.