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Preparation and Property of Bi₂Se₃/FeSe₂ heterojunction

Liang Zhenga, Tengteng Lia, Rong Jina, Ming Leia, Ke Zhaob, Xinsheng Yanga, Yong Zhanga, Yong Zhaoa, Vong Zhaoa, V

^aKey Laboratory of Advanced Technology of Materials (Ministry of Education), Superconductor and New Energy R&D Center, Southwest Jiaotong University, Chengdu, 610031, China ^bSchool of Physical Science and Technology, Southwest Jiaotong University, Chengdu, 610031, China

Abstract

 $Bi_2Se_3/FeSe_2$ heterojunctions on Si(100) substrates have been prepared by frequency magnetron sputtering technique. In the majority situation, $Bi_2Se_3/FeSe_2$ heterojunctions show ferromagnetism, accompanying with the thickness of $FeSe_2$ thin films increase, the hysteresis loop of $Bi_2Se_3/FeSe_2$ heterojunctions are more obvious. Bi_2Se_3 topology insulators have been induced by ferromagnetic $FeSe_2$ thin films, which makes the $Bi_2Se_3/FeSe_2$ heterojunction become ferromagnetism. However, $Bi_2Se_3/FeSe_2(20nm)$ heterojunction has been characterized as superconductivity and completely diamagnetism, due to the superconductor approach effect of $FeSe_2$ thin film.

Introduction and Experimental

•Magnetron sputtering technology is very popular due to its advantage: simpler and lower cost.

•Bi₂Se₃/FeSe₂ heterojunctions have been synthesized through two consecutive steps by frequency magnetron sputtering method. Firstly, FeSe₂ thin films have been grown on silicon (100) substrate, and post-annealing treatment. Secondly, Bi₂Se₃ thin films have been deposited on FeSe₂ substrate and post-annealing treatment.

Result and discussion

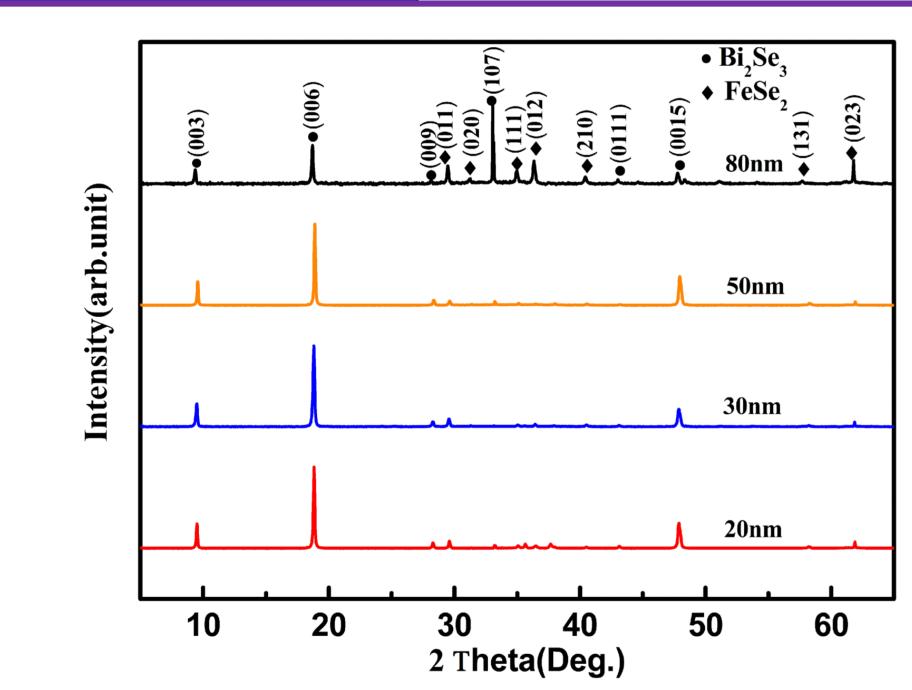


Fig. 1. XRD of the Bi₂Se₃/ FeSe₂ heterojunctions with different thicknesses

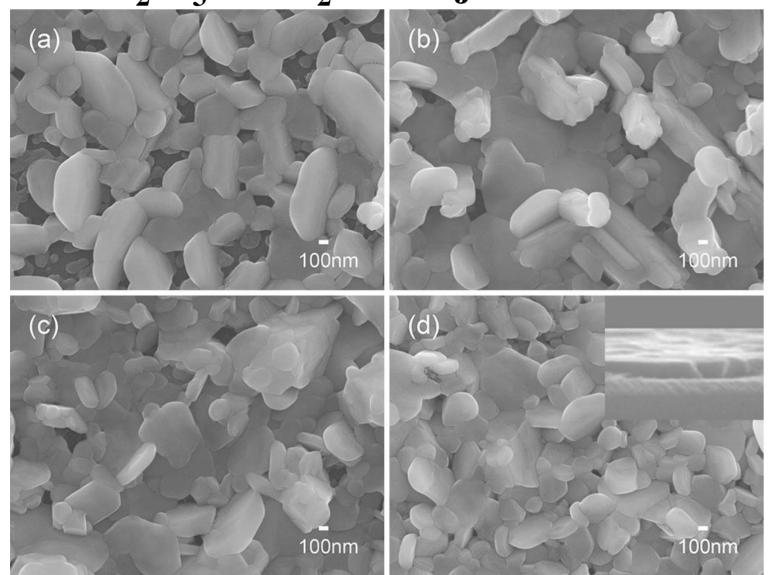


Fig. 2. SEM of Bi₂Se₃/FeSe₂ heterojunctions with different thicknesses (a-20nm,b-30nm,c-50nm,d-80nm)

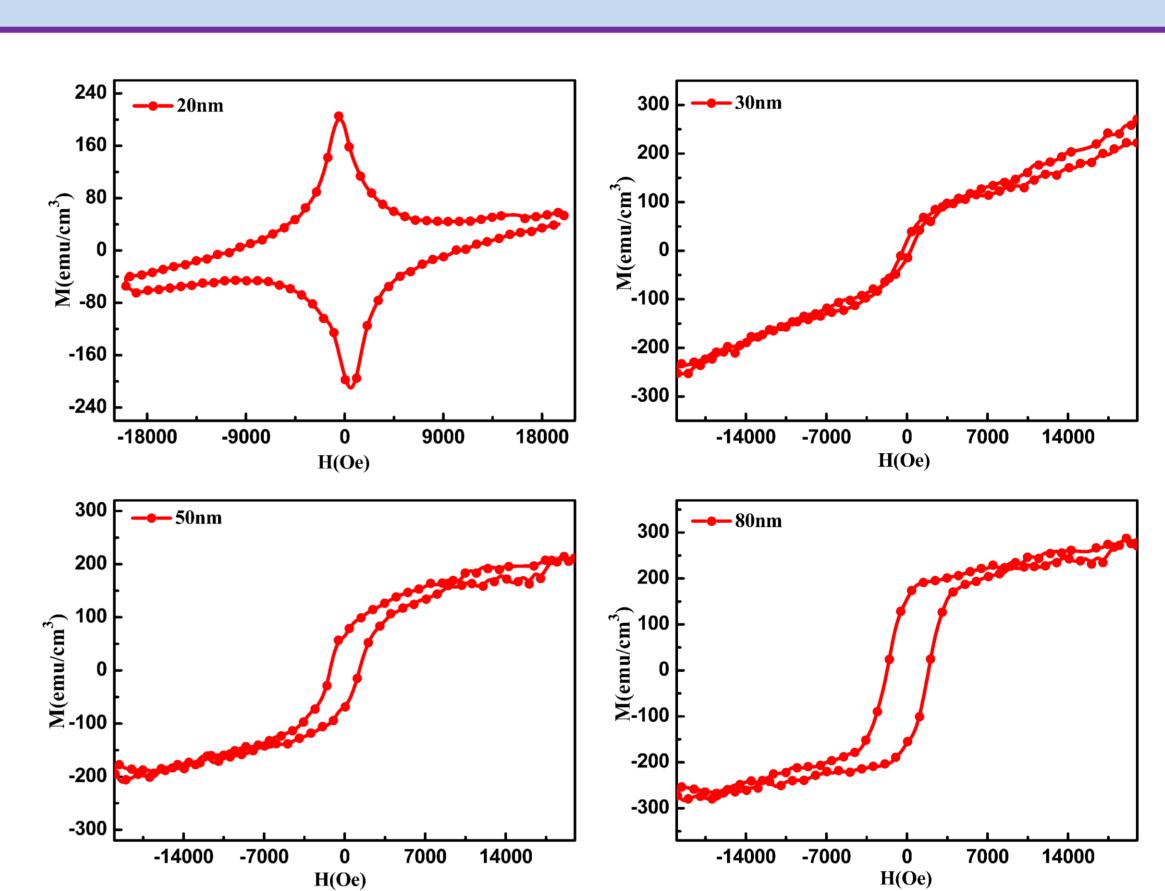


Fig. 3. Magnetization curves of Bi₂Se₃/FeSe₂ heterojunctions with different thicknesses in 10K

Table.1 Bi₂Se₃ / FeSe₂ heterojunctions with different thicknesses in 10K

T	Thickness of	Coercive	Saturation	Residual
	$FeSe_2$	force $H_{\rm c}$	susceptibility	susceptibility
	film(nm)	(Oe)	$M_{\rm Smol}$ [emu/cm ³]	$M_{ m r}$
				[emu/cm ³]
	20	8500	53	205
	30	520	260	23
	50	220	210	60
	80	830	270	160

M-H equation

$$Jc = 20 \times (M/V) \times a \times (1-a/3b)$$

• Jc=5.5×10⁶ A/cm³, as same as conventional superconducting material in 10 k

Conclusion

Bi₂Se₃/FeSe₂ heterojunctions have been prepared by radio frequency magnetron sputtering. Bi₂Se₃/FeSe₂ heterojunctions have pure FeSe₂ and Bi₂Se₃ phases, and the thickness of FeSe₂ thin film is one particularly significant factor for subsequent deposition of Bi₂Se₃ thin film. Bi₂Se₃/FeSe₂(20nm) heterojunction is completely diamagnetic due to the magnetic proximity effect between Bi₂Se₃ thin film and FeSe₂ thin film. The magnetization of Bi₂Se₃/FeSe₂ heterojunctions become more hysteresis loop and ferromagnetism with the increasing thickness of FeSe₂ thin film, due to the stronger inducement effect from FeSe₂ thin film. So FeSe₂ ferromagnetic film has been introduced into Bi₂Se₃ topology insulator to make Bi₂Se₃/FeSe₂ heterojunction, which is an effective way to make Bi₂Se₃ topology insulator to have more practical value.

