Supplementary Information

Abnormal Room Temperature Ferromagnetism in CuO/ZnO Heterostructures: Interface Related or Not?

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S1: Experiment and Characterization sections

Synthesis of CuO/ZnO particle-heterostructures: High purity CuO and ZnO powders were mixed with different molar ratios (ZnO:CuO=100:0, 83:17, 67:33, 50:50, 33:67, 17:83, 0:100) and then milled at 300 rpm at room temperature for 12 h using a planetaty mill (QM-3SP2) and an agate vial with agate balls in the air. Water as a solvent was used (wet gringing) and the ball/powder ratio was 15:1 by weight. For convenient, these samples were denoted as PZ100C0, PZ83C17, PZ67C33, PZ50C50, PZ33C67, PZ17C83, and PZ0C100. Parts of the obtained powders were annealed in atmosphere at different temperatures for 2 h.

Synthesis of CuO/ZnO film-heterostructures: The CuO/ZnO film-heterostructures with the thickness of 240 nm were prepared using the sol–gel method. In brief, 0.5 M zinc acetate dihydrate [$Zn(CH_3COO)_2 \cdot 2H_2O$] and 0.5 M copper acetate [$Cu(CH_3COO)2 \cdot H_2O$] were dissolved in a mixture of 2-methoxyethanol and monoethanolamine which served as the solvent and stabilizer, respectively. The resultant solution was stirred at 60 °C for 3 h and then aged for 2 days. The ready solution was then deposited on normal glass substrates using the spin-coating technique at 3000 rpm for 30 s. And then the as-deposited films were immediately placed into a furnace of 300 °C and hold for 10 min. In order to get the CuO/ZnO film-heterostructures with different interface counts, the ready solution for the CuO and ZnO were spin-coating alternately. Finally, the samples were heated in air to 550 °C for 1 h and then cooled in furnace to the room temperature. We denoted CuO/ZnO film-heterostructures as *n*[CuO/ZnO], where *n* stand for the interface count of the sample.

Characterization: X-ray diffraction (XRD, X' Pert PRO PHILIPS with Cu Kα radiation) and X-ray photoelectron spectroscopy (XPS, Kratos Axis Ultra) were employed to study the crystal structure and the bonding characteristics of the samples. We used the method of argon ion etching to measure the interface

information of the samples. The composition was confirmed by an inductively coupled plasma atomic emission spectrometer (ICP, ER/S). The measurements of magnetic properties were made using the Quantum Design MPMS magnetometer based on superconducting quantum interference device (SQUID).

S2: ICP results for the representative sample PZ50C50.

Element content (ppm)	Fe	Co	Ni	Mn	Cr
First	6.2	2.0	0.6	0.0	0.8
Second	7.1	1.8	0.8	0.2	1.0

Table S1. ICP results for the sample PZ50C50.

S3: Annealing temperature dependence on the saturation magnetization (M_s) for the samples.

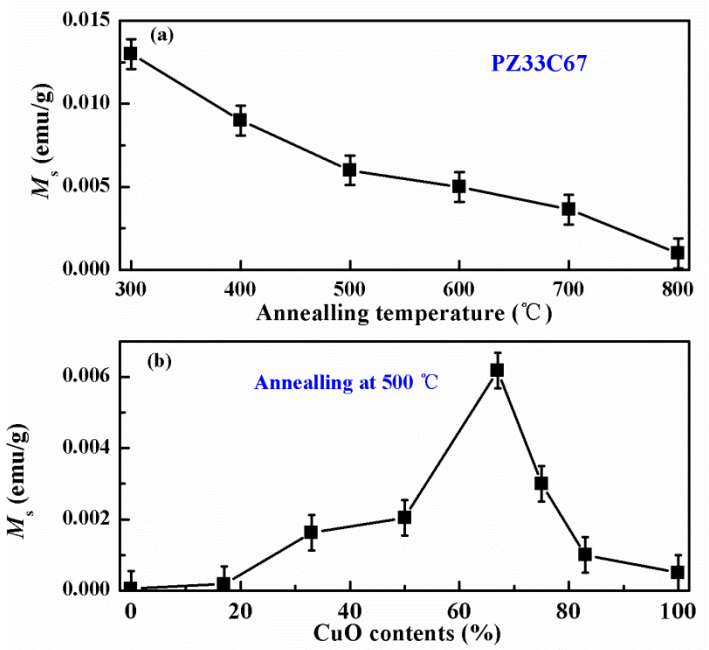

Fig. S1 Annealling temperature dependence on the saturation magnetization (M_s) for the samples.

S4: Magnetization curves (M-H) at the low field range of the CuO/ZnO heterostructures measured at room temperature.

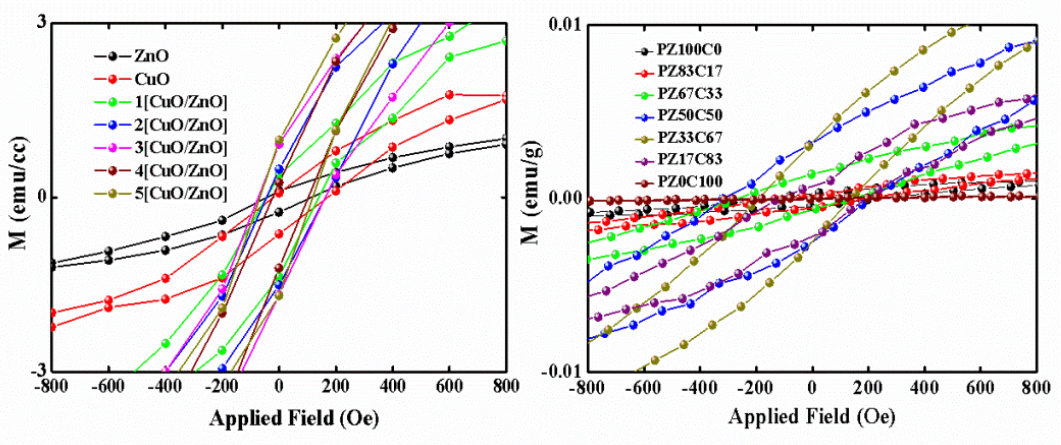

Fig. S2 Magnetization curves (M-H) at the low field range of the CuO/ZnO heterostructures measured at room temperature.

S5: Magnetic properties of CuO nanoparticles ball-milled at different time.

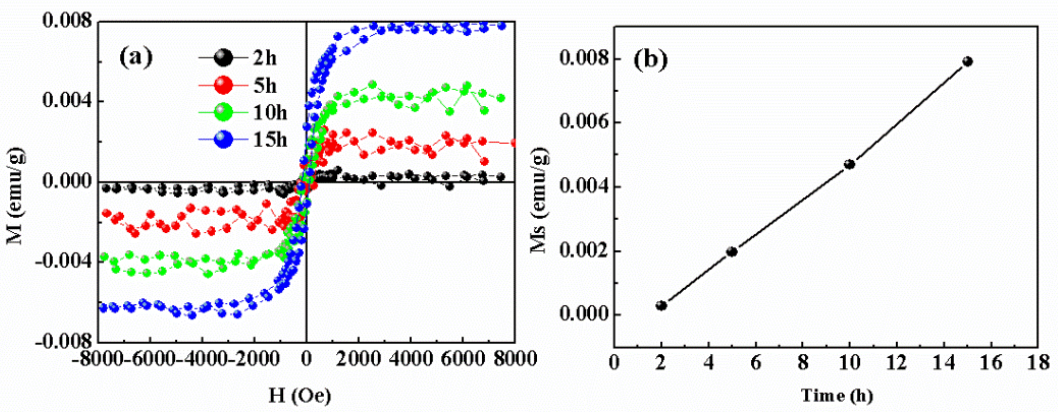

Fig. S3 Magnetic properties for CuO ball-milled at different time.

S6: Wide XPS spectrum for the representative sample of 5[CuO/ZnO]

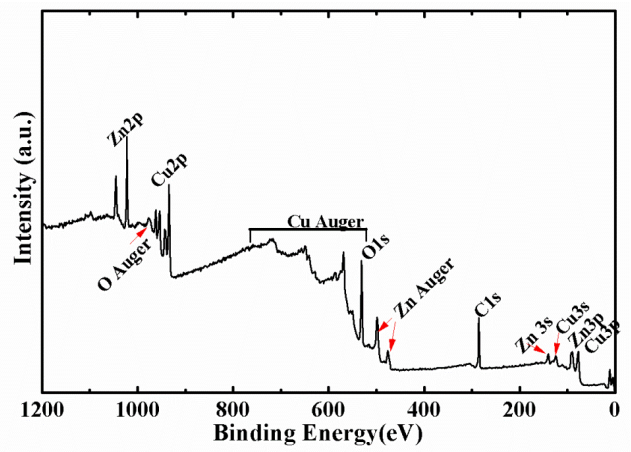

Fig. S4 Wide XPS spectrum for the representative sample of 5[CuO/ZnO]

S7: High resolution scan of Zn 2p and Cu 2p XPS spectrum for sample PZ33C67.

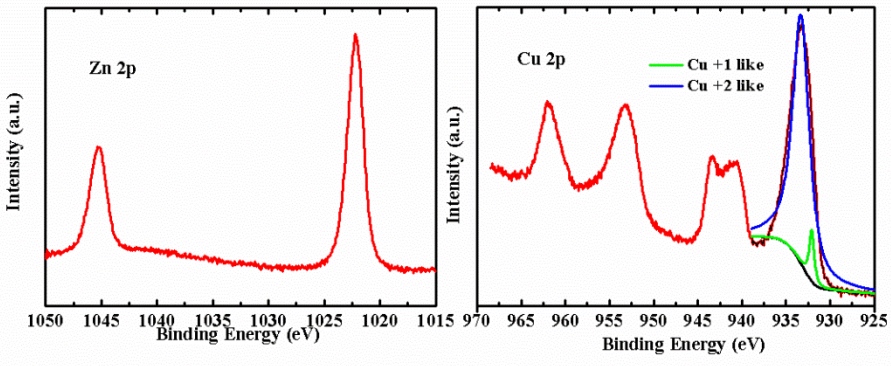

Fig. S5 High resolution scan of Zn 2p and Cu 2p XPS spectrum for sample PZ33C67.

S8: XPS high resolution scan of Cu 2p3/2 spectrum at the interface for sample 5[CuO/ZnO] by Ar ions etching method measured at different times.

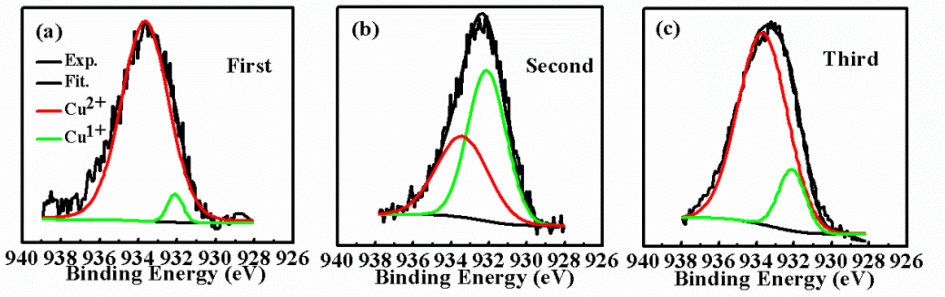

Fig. S6 XPS high resolution scan of Cu $2p_{3/2}$ spectrum at the interface for sample 5[CuO/ZnO] etching at different number of times with argon ion.