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Supplementary Materials

Large magnetocaloric effect of $GdCoO_{3-\delta}$ epitaxial thin film prepared by polymer assisted spin-coating method

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S. 1 XPS results and Discussion

In order to investigate the near-surface elemental composition and the oxidation state of the elements in the GCO film, XPS has been carried out. The high-resolution spectrum of adventitious C 1*s* with binding energy (BE) peaks at 284.8 eV [1] was chosen as the criteria for the calibration of the binding energies of all detected elements in GCO film. The quantitative analysis based on XPS indicated that atomic ratios Gd:Co in the GCO sample was 1:1, consistent with the XRD result. As shown in Fig. S1(a), the Co 2*p* spectrum could be fitted with two spin-orbit doublets, corresponding to Co^{2+} with BE peaks at 780.6 ev and 796.3 ev and Co^{3+} with BE peaks at 779.6 ev and 794.6 ev, and their shake-up satellites (identified as "Sat.") situated at 789.9 ev and 805.1 ev, respectively. Similar result has been reported in $LaCoO_3$ [2], $DyCoO_3$ [3], and $Ca_3Co_2O_6$ [4]. The change in the oxidation state of the cobalt from Co^{3+} to Co^{2+} may attribute to the nature of charge conservation considering

oxygen vacancies. As displayed in Fig. S1(b), the fitted O 1*s* XPS spectra show two major oxygen contributions centered at about 528.8 and 531.2 eV, which are ascribed to lattice oxygen (O_{latt}), surface adsorbed oxygen (oxygen defects, O_{ads}). Similar result has been reported in $LaCoO_3$ [2]. In addition, the ratio for Co^{3+}: Co^{2+} (53.98% : 46.02%) and O_{latt} : O_{ads} (54.32% : 45.68%) have been determined by Co 2*p* XPS spectrum fitted and O 1*s* XPS spectrum fitted, respectively.

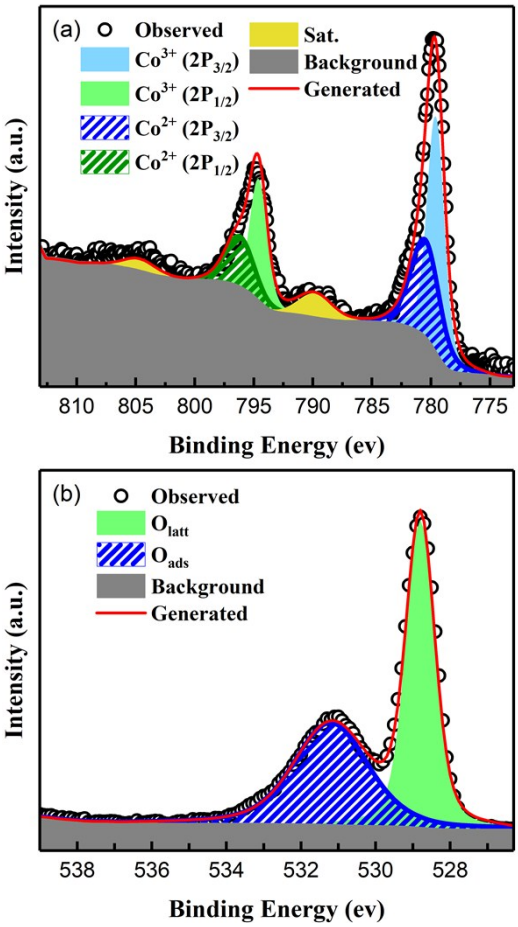

Fig. S1 (Color online) The Co 2*p* XPS spectra (a) and O 1*s* XPS spectra (b) of GCO thin film fitted in the Avantage software.

S. 2 $\chi^{-1}(T)$ curve

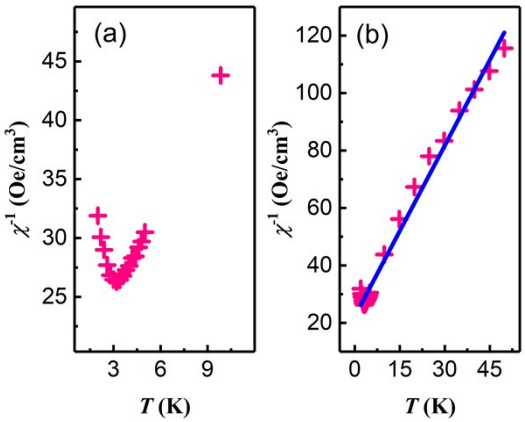

Fig. S2 (Color online) (a) The temperature dependence of the reciprocal of the magnetic susceptibility $\chi^{-1}(T)$ curve around transition temperature for GCO/LAO after subtracting diamagnetic signal from the sample holder and the substrate. (b) $\chi^{-1}(T)$ curve and beeline fitting (blue solid line).

S. 3 $M(H)$ curve

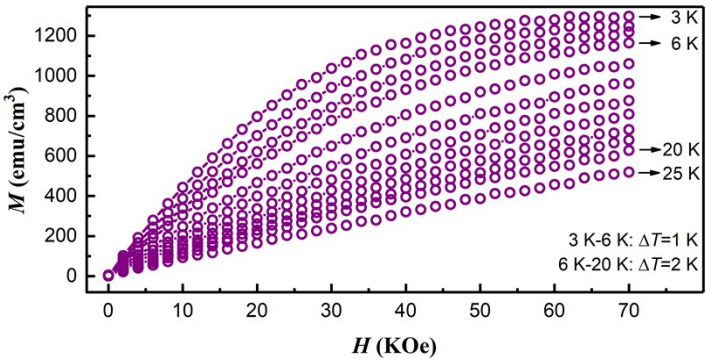

Fig. S3 (Color online) $M(H)$ curves of GCO/LAO after subtracting diamagnetic signal from the sample holder and the substrate.

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