Giant Exchange Bias Properties in “314 –type” Oxygen-Vacancy Ordered Materials

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The intriguing fundamental and technological aspects of the exchange bias (EB) effect have garnered great interest since the discovery by Meiklejohn and Bean. Recent developments on EB have highlighted its usefulness in several technological applications such as in magnetic recording read heads, thermally assisted magnetic random-access memories, and other spintronic devices. Recently, nearly compensated ferrimagnetic systems (such as $Mn_{3-x}Pt_xGa$ [1]) have attracted immense interest due to their ability to show giant EB effect. A small lack of compensation, which is formed as a consequence of intrinsic antisite disorder originates the giant EB effects in these systems and indeed provides a novel approach to design new materials with a large EB [1]. For the feasibility of room temperature application, it would be worth to study the nearly compensated ferrimagnetic materials having transition higher than the room temperature to explore the exchange bias. In this context, the nearly compensated 314–type ferrimagnetic systems ($Sr_{0.75}Y_{0.25}CoO_{2.62}$ and $SrFe_{0.15}Co_{0.85}O_{2.62}$) with ferrimagnetic transition above room temperature is an interesting material system to search for a magnetically compensated material to observe exchange bias [2, 3].

Herein, we report the exchange bias effect in $Sr_{0.75}Y_{0.25}CoO_{2.62}$ and $SrFe_{0.15}Co_{0.85}O_{2.62}$ materials. Large exchange bias effect (figure 1) is observed below their ordering temperature (340 K and 315 K for $Sr_{0.75}Y_{0.25}CoO_{2.62}$ and $SrFe_{0.15}Co_{0.85}O_{2.62}$ respectively) when the samples are cooled in the presence of a magnetic field. The coexistence of nearly compensated and ferrimagnetic regions in the layered structure originate exchange bias in these samples. The appearance of a giant exchange bias effect, especially near room temperature indicates that 314-type cobaltates are a promising class of material systems for the exploration of materials with potential applications as magnetic sensors or in the area of spintronics.

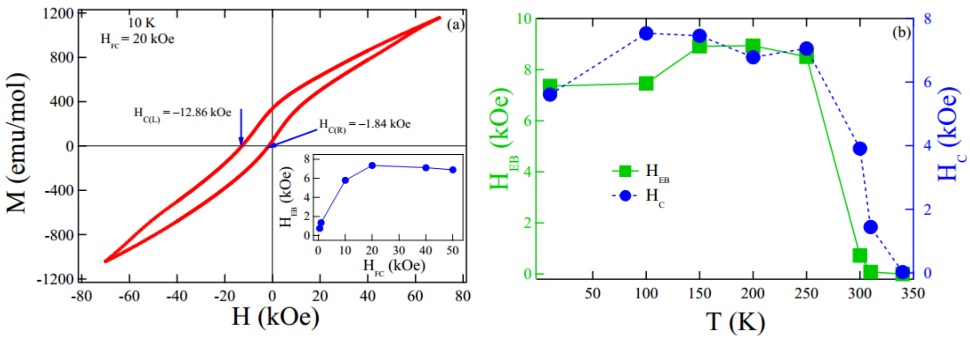

Figure 1. (a) Magnetic field dependent magnetization loop (M-H) of $SrFe_{0.15}Co_{0.85}O_{2.62}$ at 10 K measured in field cooling mode (FC, cooling field H_{FC} = 20 kOe). The inset shows cooling field (H_{FC}) dependence of the H_{EB} measured at 10K. (b) Temperature dependence of (left axis) H_{EB} and (right axis) coercivity for the same.

[1] http://www.nature.com/nmat/journal/v14/n7/abs/nmat4248.html?foxtrotcallback=true

[2] https://www.nature.com/articles/srep19762

[3] http://aip.scitation.org/doi/abs/10.1063/1.4985104?journalCode=apl