

Temperature studies of magnetic properties of Pd/Co/CoO epitaxial films



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Abstract

An exchange bias has been found in $[\text{Pd}/\text{Co}/\text{CoO}]_n$ epitaxial films with different oxidation depths and different repetition numbers (n) characterized by perpendicular magnetic anisotropy. The oxidation parameters and the number of bilayers affect the exchange bias. The Néel temperature depends on the thickness of the Co oxide and does not depend on the number of bilayers before $n=4$.

Experiment

Making films:

Molecular beam epitaxy

$P_{\text{base}} = 2 \cdot 10^{-10}$ Torr

Oxidation in oxygen

$P = 1$ at.

Research methods:

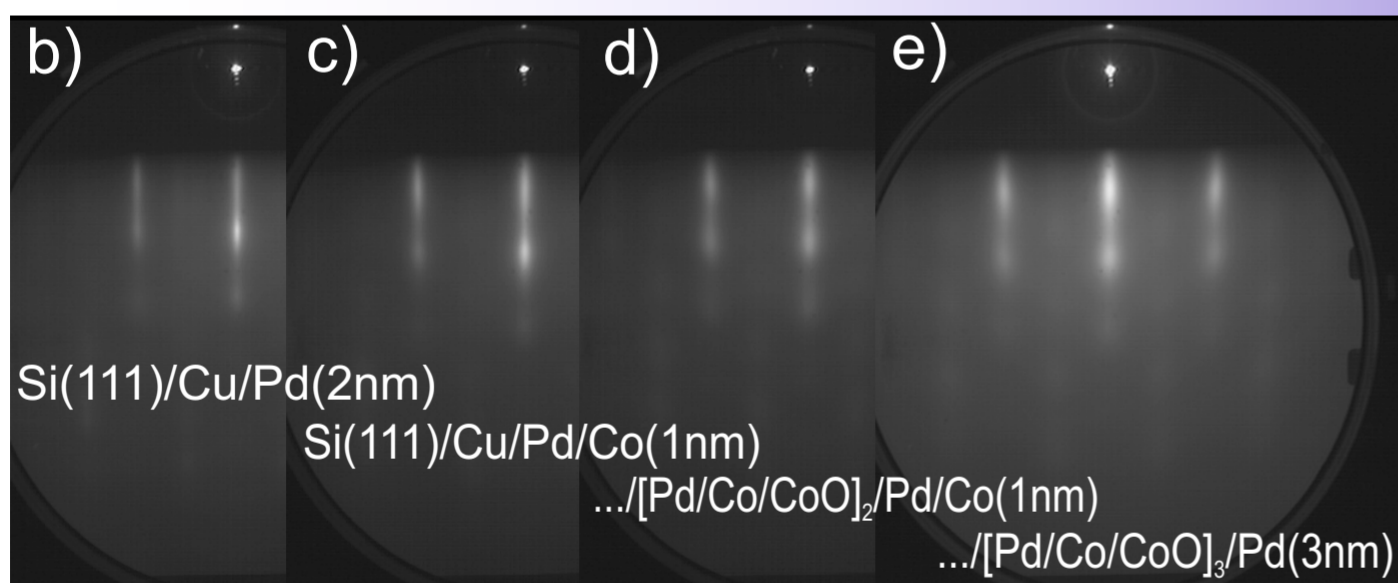
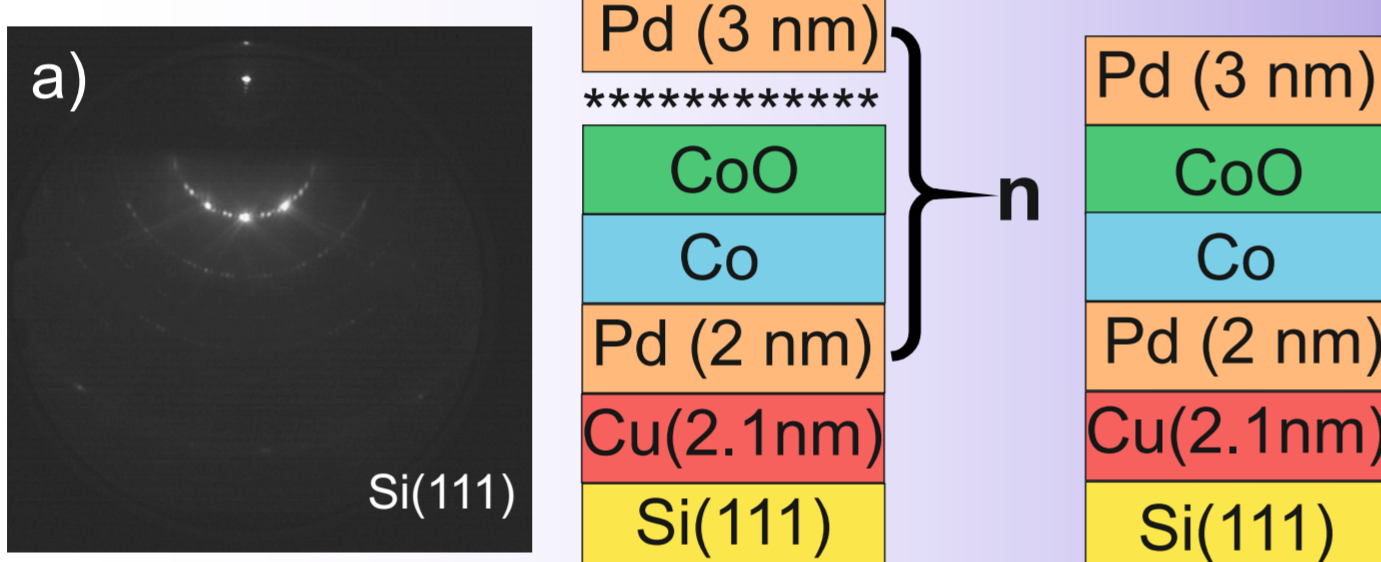
Structure

RHEED

Magnetic properties

SQUID, VSM

Structure



The structure of the films was studied in situ by the RHEED method: (a) - substrate as Si(111),

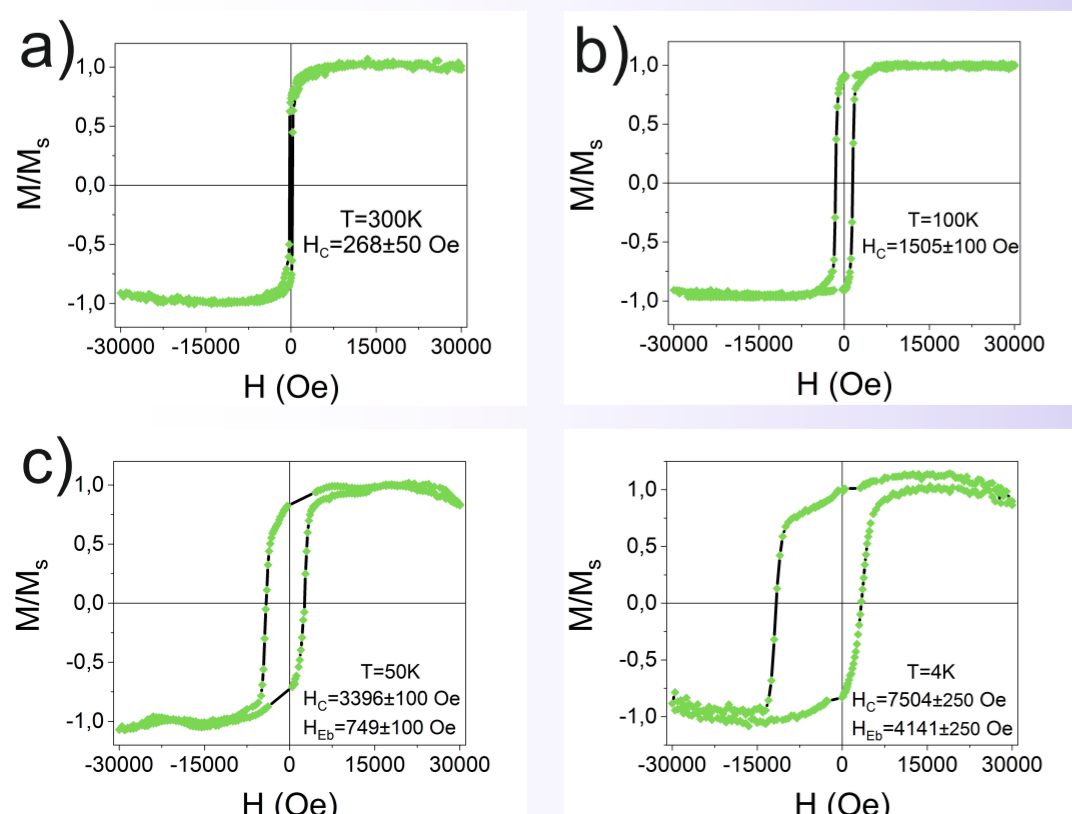
(b) - lower layer Pd (2nm),

(c) - Co layer (1nm) before oxidation,

(d) - the third layer of Co (1nm),

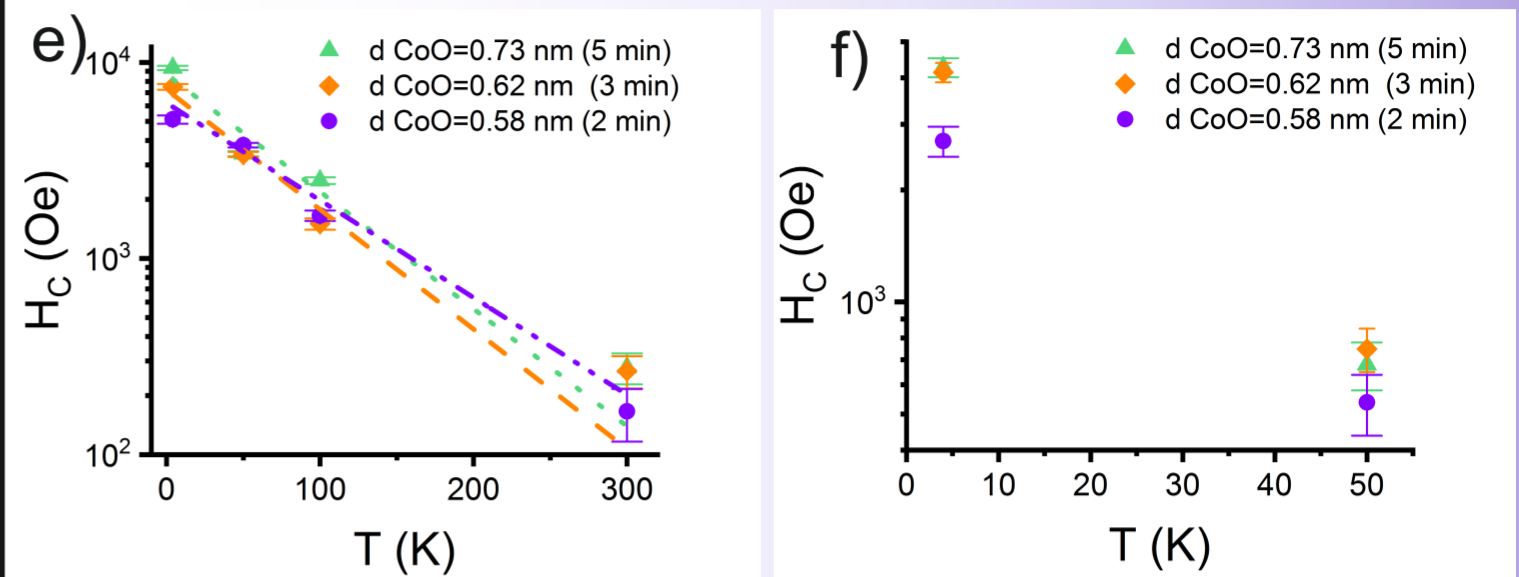
(e) - Pd protective layer (3nm).

Exchange bias in Pd/Co/CoO films with different CoO thickness and with different n

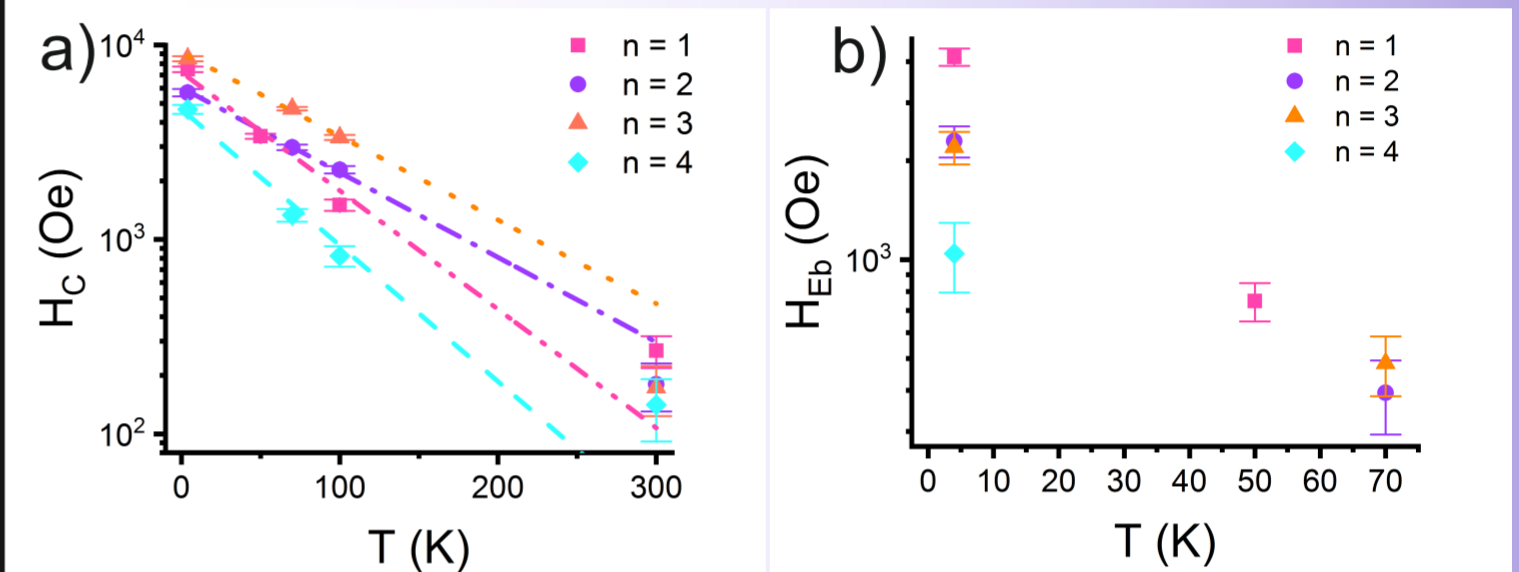


Magnetic hysteresis loops at temperatures:

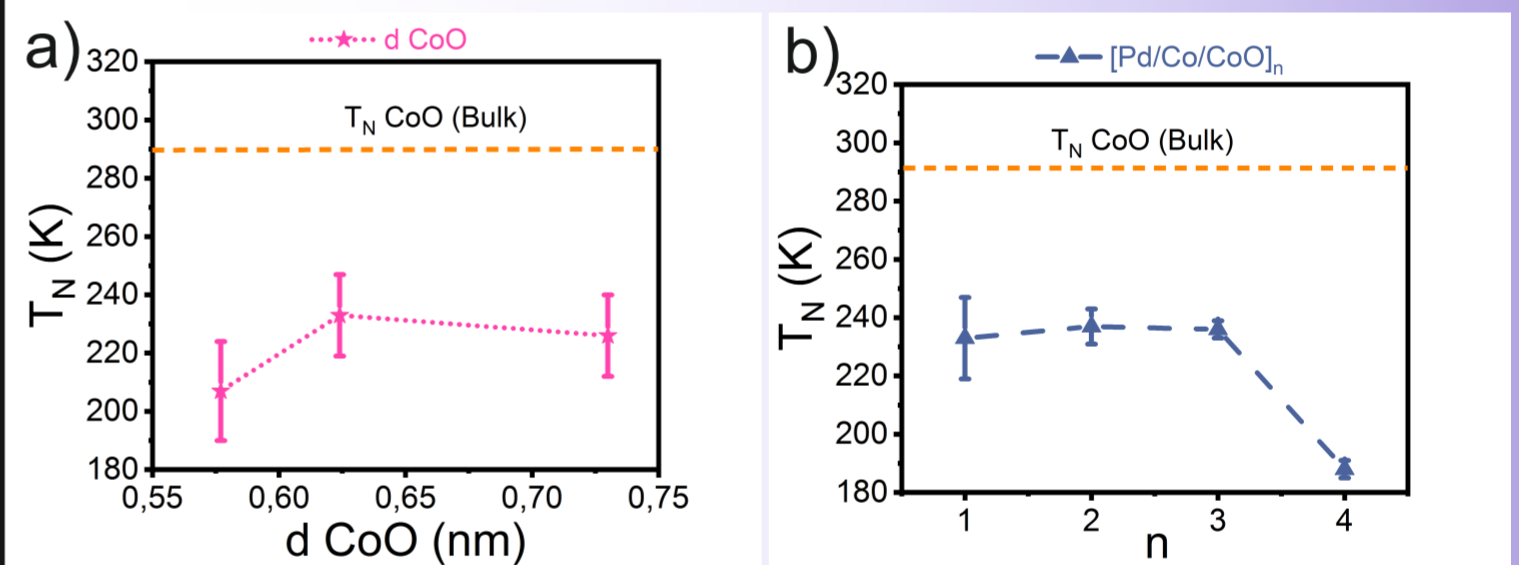
(a)-300K,
(b)-100K,
(c)-50K,
(d)-4K,
d CoO=0,62 nm.



Dependences of the exchange bias (e) and coercive force (f) on temperature for samples with different thicknesses of CoO



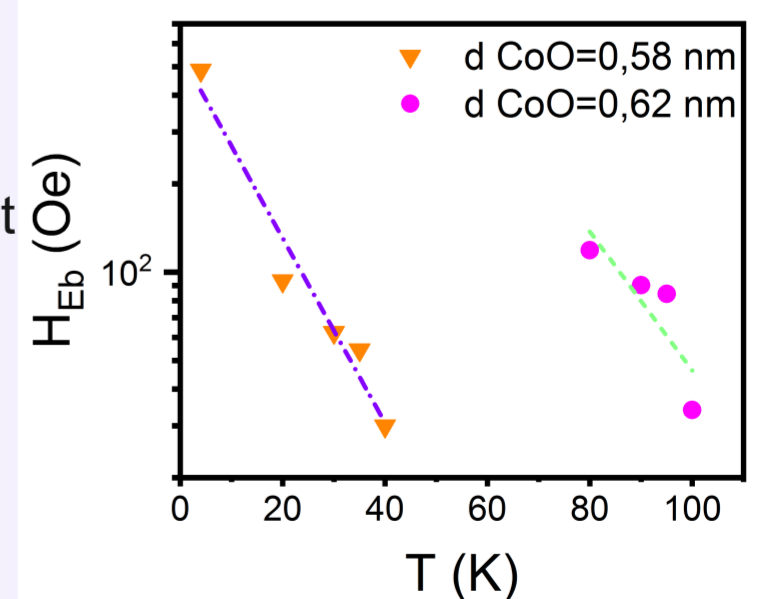
Temperature dependences of (a) exchange bias and (b) coercive force for samples with different number of repetitions Pd/Co/CoO. d CoO=0,62 nm.



Dependences of the Néel temperature on the thickness d of CoO (a) and on the number of repetitions of bilayers n [Pd/Co/CoO] (b).

Blocking temperature

To search for the blocking temperature [1], two experiments were carried out with a small temperature step.



Conclusion

The possibility of the existence of an exchange bias perpendicular to the film plane in Pd/Co/CoO epitaxial structures with different oxygen exposition of Co and $[\text{Pd}/\text{Co}/\text{CoO}]_n$ oxidation, which are characterized by perpendicular magnetic anisotropy, has been shown. It was found that the exchange bias depends on the exposition parameters and on the number of bilayers. The Neel temperature depends on the thickness of the Co oxide and does not depend on the number of repetitions before $n=3$.

[1] J. Nogués, JMMM V. 192(2), (1999) pp. 203-232.