Tohoku Univ. Technology

Magnetic sensor

Tunnel magneto-resistive sensor (TMR sensor) with high sensitivity and accuracy

TMR sensor application

Image from http://denso-europe.com/

Used area | Error margin | Safety margin

30%

60%

Current status of EV battery

Enormous efficiency improvement by TMR sensor

Overview

Various magnetic sensors such as the Hall sensor, are widely used for the realization of an advanced IoT society. In particular, magnetic sensors based on the tunnel magnetoresistance effect (TMR sensor) discovered at Tohoku University has made dramatic progress in increasing sensitivity, making it possible to detect a weak magnetic field such as bio-magnetic field.

However, the conventional TMR sensor did not achieve both high sensitivity and accuracy.

This invention is able to provide a TMR sensor with extremely high linearity output which is necessary to achieve high sensitivity and accuracy, by controlling the higher-order magnetic anisotropy of the used ferromagnetic material.

Product Application

- ☐ Current sensor able to monitor with high accuracy the battery current of an electric vehicle, etc.
- ☐ Non-destructive testing sensor that can detect with high accuracy the corrosion or deterioration of infrastructures
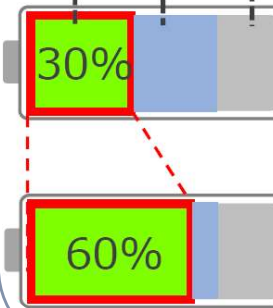
IP Data

IP No.	: JP2019-198090
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Features・Outstandings

Structure of the invented TMR sensor

H

Ta/Ru	
CoFeB	t_{CoFeB}
MgO	(2.0)
CoFeB	(0.8)
Ta	(0.3)
[Pt (0.4)/ Co (0.2)]$_7$	(4.2)
Co	(0.2)
Ru	(0.4)
Co	(0.2)
[Co (0.2)/ Pt (0.4)]$_9$	(5.4)
Ta/Ru/Pd	
Si/SiO$_2$-sub.	(nm)
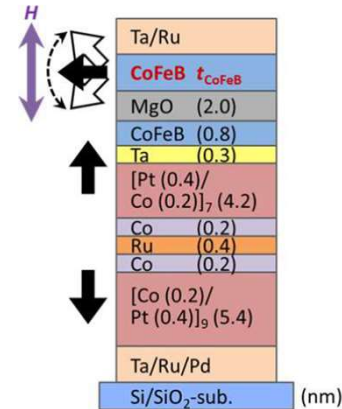
Relationship between magnetic anisotropy and nonlinearity (NL) in a magnetic material

Point : Experiment
Surface : Calculation

NL^{max} (%)

$H_{u2}/|H_k^{eff}|$ (norm.) $H_d/|H_k^{eff}|$ (norm.)
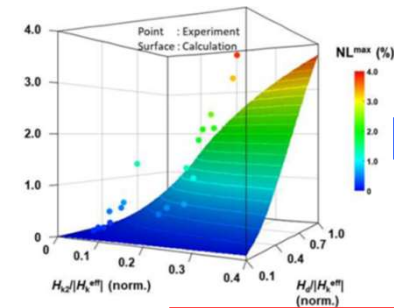
High sensitivity / accuracy
High sensitivity: >50m%/Oe
Low nonlinearity: <1.0 %

Related Works

[1] Takahiro Ogasawara, Mikihiko Oogane, Muftah Al-Mahdawi, Masakiyo Tsunoda, and Yasuo Ando, Scientific Reports, 9, 17018 (2019)

Contact

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