MAE cantilever-type acceleration sensor with adjustable sensitivity

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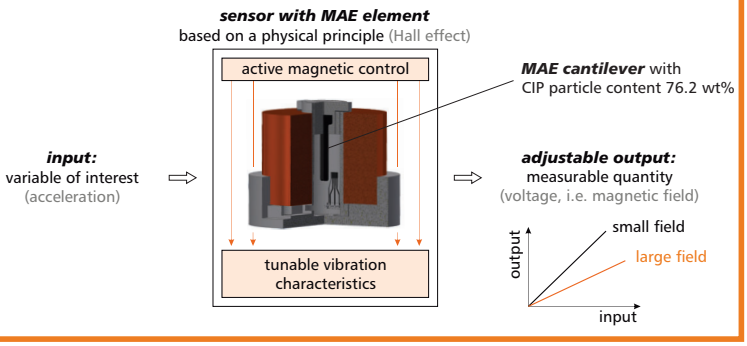
Sensor functioning principle

In application involving crashes and falls, an acceleration sensor may experience sudden, short-duration impulsive loads and should withstand them without failure.

The use of ***magnetoactive elastomers*** (MAEs) in the design of functional proof elements can enable adjustable sensor sensitivity tailored to specific application requirements.

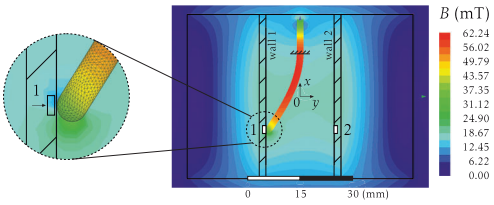
Underlying effect: contactless adjustable mechanical properties of MAEs in a magnetic field

➔ Enhancement of the measurement accuracy and the expanded operating range for different acceleration levels

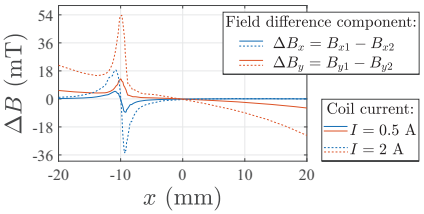


Detection of MAE vibrations by magnetic field sensing

Magnetostatic analysis in ANSYS Maxwell



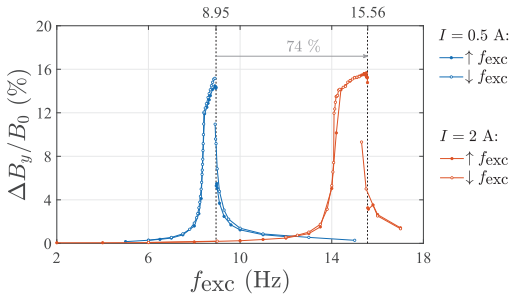
- Magnetic field sensing strategy using two analog-bipolar Hall effect sensors placed in the plane of bending vibrations of the MAE cantilever
- The optimal vertical position (x=–10 mm) and the horizontal orientation of the sensors with a sensitivity of 23 mV/mT



Sensor frequency response

The resonance characteristics of the sensor are identified by the frequency response to a kinematic harmonic excitation.

Normalized field distortion as the steady-state amplitude response for two supplying coil currents:



➔ Current-induced shift of the resonant peak towards increasing excitation frequency

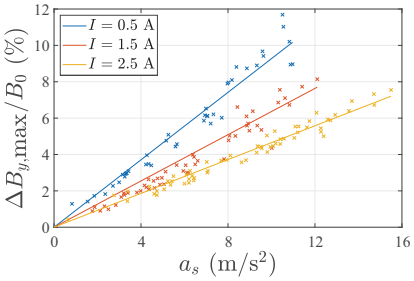
➔ The sensor operating sensitivity can be reversibly and separably switched between the low, high or resonance responses to the same applied excitation.

Sensor response to a mechanical shock

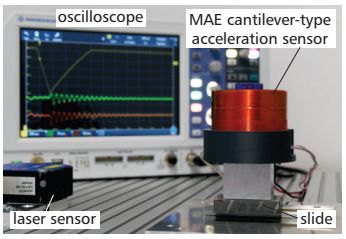
The shock response is analyzed in the time domain, focusing on the peak acceleration a_s and field change sensed immediately after a mechanical shock load of duration t_s.

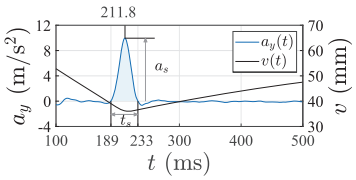
Sensor sensitivity, in terms of relative field distortion, to shock acceleration for different coil currents:

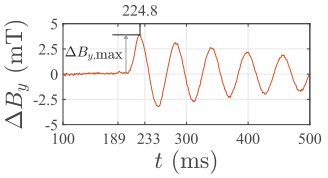
$$\Delta B_{y,\max}/B_0(I) = S(I) \cdot a_s$$



➔ Lower sensitivity factor $S(I)$ at higher coil currents







Coil current I (A)	Sensitivity factor S (s²/m)
0.5	0.927
1.5	0.636
2.5	0.465

Outlook

The MAE cantilever-type acceleration sensor features current-adjustable sensitivity, making it advantageous over conventional accelerometers, which often have a fixed working range that limits their performance.

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