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Magnetic sensors with superior performance: material and design optimization for angular sensing

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Magnetoresistive (MR) sensors measure magnetic field intensities with high precision by leveraging resistance changes. Tunneling Magnetoresistance (TMR) sensors, like other MR sensors, rely on the angular difference between the magnetic moments of the Free Layer (FL) and the Reference Layer (RL) to determine resistance. While TMR sensors excel in sensitivity and performance, a key challenge is stabilizing the RL magnetic moment in high-field environments, where deviations can compromise the accuracy by shifting the system's reference.

This project aims to optimize TMR sensors for angular measurements by addressing three primary challenges: enhancing RL stability, extending the operational range (plateau range), and minimizing deviations from measured field directions. Using a Stoner-Wohlfarth-based framework, the effects of anisotropies, coupling mechanisms, geometry and materials on sensor performance were investigated. These insights guided the development of optimized designs, for later to be implemented in a Wheatstone bridge configuration to reduce deviations and enhance sensing accuracy. The iterative combination of simulation and experimental validation will advance TMR sensors for superior angular field measurements.

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