A Novel Spintronics-based Circulating Tumor Cell Biosensor for Early Metastasis Detection

Shafi, Mahmood (School: Advanced Generations International School - Boys)

Cancer spreads throughout the body in a process named metastasis. Circulating tumor cells (CTCs) play a critical role in promoting metastatic cancers, which cause approximately 90% of cancer-related deaths. Existing methods of metastasis and CTC detection are time-consuming, too invasive, harmful, or not capable of detecting metastasis until it has already happened. Recently, spintronic devices such as the magnetic tunnel junction (MTJ) sensors have been applied in various biomedical applications. The purpose of this study is to fabricate a MTJ sensor capable of detecting the magnetic microparticles (MMPs) used for magnetic labeling of CTCs. The MTJ sensor is fabricated, characterized, then used to detect MMPs to simulate CTC detection. The characterization results show a non-hysteresis response at low magnetic field values, along with a tunneling magnetoresistance ratio of 123.8% in the MTJ, which aligns with detection of MMPs and indicates high sensor sensitivity. MMPs were also detected when passed over the sensor, simulating CTC detection. Moreover, The proposed CTC detection concept is outlined, where MMPs bind to EpCAM, a CTC biomarker that is considered to be universal for almost all cancer CTCs. The magnetically labeled CTCs then flow through a microfluidic channel and pass over the MTJ sensor, which will sense the magnetic field and detect them. This research produces a novel approach to CTC detection that utilizes MTJ sensors to detect CTCs, proposing a less harmful, non-invasive, and quicker method of metastasis diagnosis, contributing significantly to available point-of-care technology in this field.

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