Wearable Metasurfaces for Brain Activity Tracking

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Electroencephalography (EEG) is an essential tool for measuring brain activity in preclinical animal models and diagnosing neurological diseases in clinical settings. Traditional wired EEG systems are bulky, restrict mobility, are prone to noise, and cause discomfort—particularly limiting studies involving subjects in motion. The need for portability without sacrificing accuracy has driven the development of compact, wireless EEG sensors. However, miniaturization poses challenges in power supply and data communication. Current wireless EEG sensors rely on bulky batteries that require frequent replacement, and their wireless modules consume significant power, limiting data rates to conserve energy and restricting continuous data acquisition.

Metasurfaces offer a promising solution by enabling efficient wireless power transfer and high-speed communication with a significant reduction in weight. In this talk, I will discuss a compact, fully implanted EEG sensor enabled by a wearable metasurface. The metasurface supports wireless power without compromising data communication. The integrated sensor enables two-channel EEG recording and communicates with a host computer to monitor freely moving animals in vivo. Its flexible design is suitable for long-term EEG acquisition, providing up to a 13.7-fold enhancement in wireless power transfer efficiency through tissue and enabling sustained brain activity tracking during complex behavior studies.