# Electrically tunable magnon FET driven by dynamic redox reaction

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Spin waves (SWs) and their quanta magnons is considered to have enormous potential as beyond CMOS data carrier due to its translation motion-less or Joule heating-free data transmission capability at room temperature. In addition , SWs offer data encoding capability in amplitude, phase, and frequency, providing at least two additional degrees of freedom compared to its electronic rival. However, these enormous advantages SWs are often undermined due to a lack of energy-efficient magnon controlling technique. This report proposes a novel dynamic redox reaction-based SWs controlling technique using an Au/PEDOT: PSS/Pt/YIG heterostructure shown in Figure 1(a). The SWs excited by microwave excitation propagate through the surface of YIG, and the switching voltage is applied across PEDOT:PSS.

The propagating SWs signal $S_{21}$ with the application of 0, +2.5, and -2.5 V across the PEDOT:PSS are indicated by a black, blue, and red curve in Figure 1(b), respectively. We assumed a hydrolysis process generated H+ at the top electrodes [1], which propagated through PEDOT:PSS via Grotthuss-type mechanism towards the Pt. Upon reaching Pt, the proton reduces the partially oxidized Pt [2] at Pt/PEDOT:PSS interface resulting in an enhancement of the spin-orbit interaction (SOI) of Pt (shown in Figure 1(d-f)). SOI enhancement results in higher spin relaxation resulting in higher damping and reduction of magnetization of the Pt/YIG system. Application of opposite polarity voltage can oxidize the Pt and initiate the reverse process. The evidence of redox reaction has been demonstrated by cyclic voltammetry measurement shown in Figure 1(c).

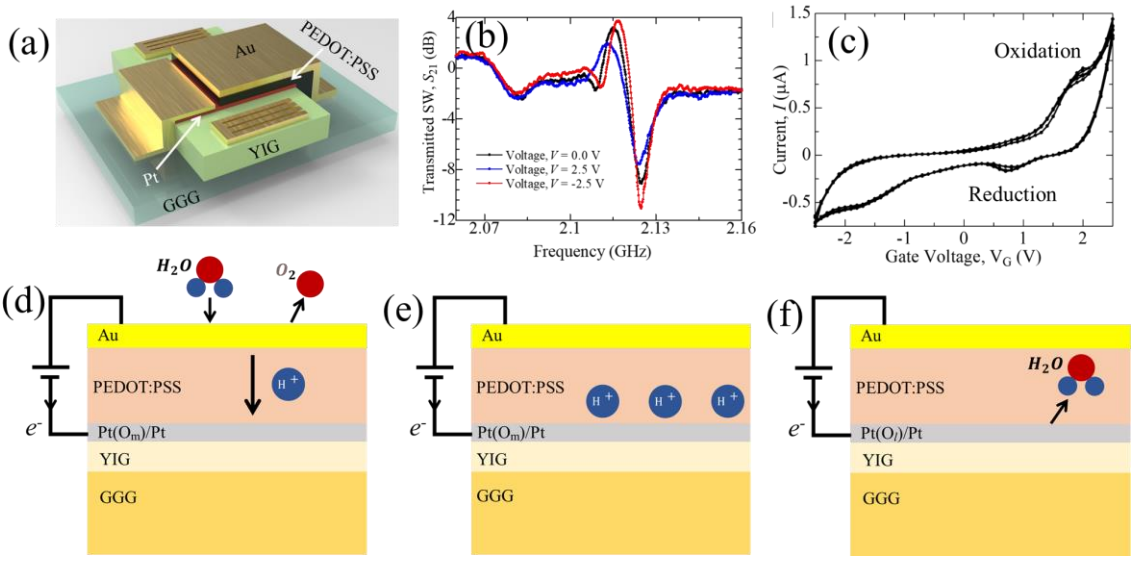


Figure 1. (a) Schematic diagram and (b) $S_{21}$ spectra of current-controlled magnon device (c) Cyclic-voltametric measurement of PEDOT:PSS (d-f) Hydrolysis and reduction process of oxidized Pt.

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**References:**

[1] A. J. Tan et al., Nature Mat., Vol. 18, p.35-41 (2019) [2] T. Li et al., Appl. Phys. Lett. **121**, 132403 (2022)