In acidic hydrogen generation, F-SnO_2@Pt required a very low overpotential (η_{10}) of 42 mV to achieve a current density of 10 mA·cm^{-2} (5 mV lower than that of Pt/C), with greater mass activity and turnover frequency (TOF) values than Pt/C. Moreover, the hybrid exhibited high stability, showing minimal degradation after 10,000 cyclic voltammetry cycles. The enhanced catalytic effect and structural robustness of F-SnO_2@Pt, originating from the aerogel system, can be explained by four key factors: the large specific surface area (321 $cm^2 \cdot g^{-1}$) of the aerogel network, which facilitates optimal Pt catalyst dispersion and provides a high surface energy with abundant active sites for the reaction; a balanced mesoporous and macroporous structure in the F-SnO_2 aerogel, which creates favorable channels for ion migration (mass transport); F-doping that replaces O^{2-} with F^- in the SnO_2 lattice, enhancing electrical conductivity and significantly reducing charge transfer resistance; and strong metal-support interaction that modifies the Fermi level of Pt and generates excess OH groups, promoting the rapid dissociation of O-H bonds on the catalyst interface. These results confirm that the synthesized aerogel system can be utilized as a metal support for fabricating highly active catalysts for water splitting applications.

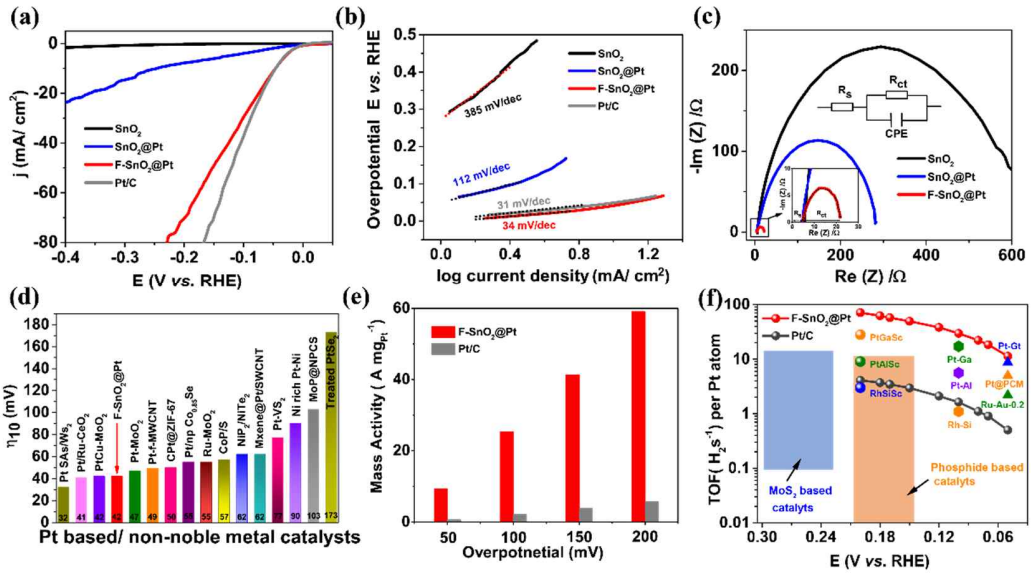

Fig. (a) Comparison of the electrochemical HER activities of SnO_2, SnO_2@Pt, F-SnO_2@Pt, and Pt/C. (b) Tafel slopes plotted from the corresponding linear sweep voltammetry curves. The dotted line indicates the linear-fitted region with its slope value. (c) Electrochemical impedance spectroscopy spectra with the equivalent circuit diagram shown in the inset. The smallest semicircle (fitted line) is observed in the F-SnO_2@Pt sample (inset). (d) Comparison of the overpotential (η_{10}) of F-SnO_2@Pt with those of previously reported high-activity catalysts. (e) Calculated mass activity and (f) TOF of F-SnO_2@Pt at different overpotentials.[1]

[1] T. Kim, S. B. Roy, S. Moon, S. Yoo, H. Choi, V. G. Parale, Y. Kim, J. Lee, S. C. Jun, K. Kang, S. Chun, K. Kanamori, H.-H. Park, ACS Nano. **16**, 1625 (2022)