

Ti₄O₇ nanoparticles composited with polypyrrole (PPy)/activated carbon foam - \(\text{ACF}\) for enhancing its service life significantly in SBF

Yue Cao¹, Yubing Qiu^{1*}, Kai Qi¹, Xingpeng Guo²

¹*School of Chemistry and Chemical Engineering, Key Laboratory of Material Chemistry for Energy Conversion and Storage (Ministry of Education), Hubei Key Laboratory of Material Chemistry and Service Failure, Hubei Engineering Research Center for Biomaterials and Medical Protective Materials, Huazhong University of Science and Technology (HUST), 1037 Luoyu Road, Wuhan 430074, P. R. China*

²*School of Chemistry and Chemical Engineering, Guangzhou University, Guangzhou, 510006, P. R. China*

* Corresponding author: qiuyubin@mail.hust.edu.cn

Presenter's e-mail address: 2392070420@qq.com

Abstract: Polypyrrole (PPy) possess excellent electrochemical properties, suitable strain-regulating mechanical property and flexibility, and low electrode/solution interface impedance, which is often used in sensing, corrosion protection, drug-carrying release, and have demonstrated promising application for implants^[1]. However, the inherent defect of polypyrrole is easy degradation, especially in solution, it is susceptible to chemical degradation caused by nucleophilic attack of OH⁻, Cl⁻ and H₂O and electrochemical degradation caused by the presence of a differential protocell of dissolved oxygen concentration, which limits its further application in biomedical field^[2]. It has been demonstrated that the stability of PPy can be improved by compositing with carbon materials and metal oxides, and Ti₄O₇ can bind to various sulfur elements according to density flooding theory (DFT) calculations^[3], so polypyrrole coatings doped with modified Ti₄O₇ particles were prepared on the surface of three-dimensional open-cell activated foam carbon electrodes using electrochemical deposition, and Ti₄O₇ particles were bound to S in sodium p-toluenesulfonate through S-O-Ti bonds, and then further bind to PPy through electrostatic interactions, making the composite coating structure more dense and difficult for corrosive ions to exchange with counterions. In this paper, the corrosion degradation process of Ti₄O₇+PPy/C complex in human simulation body liquid (SBF) for 90 days was investigated. Both cyclic voltammograms and electrochemical impedance spectra show that the complex still maintains a good electrochemical activity after 90 days of immersion experiments, and SEM maps show that a great number of Ti₄O₇ particles as well as typical PPy morphology still exist on the surface of the complex. Therefore, this paper provides an effective way to improve the chemical stability of polypyrrole.

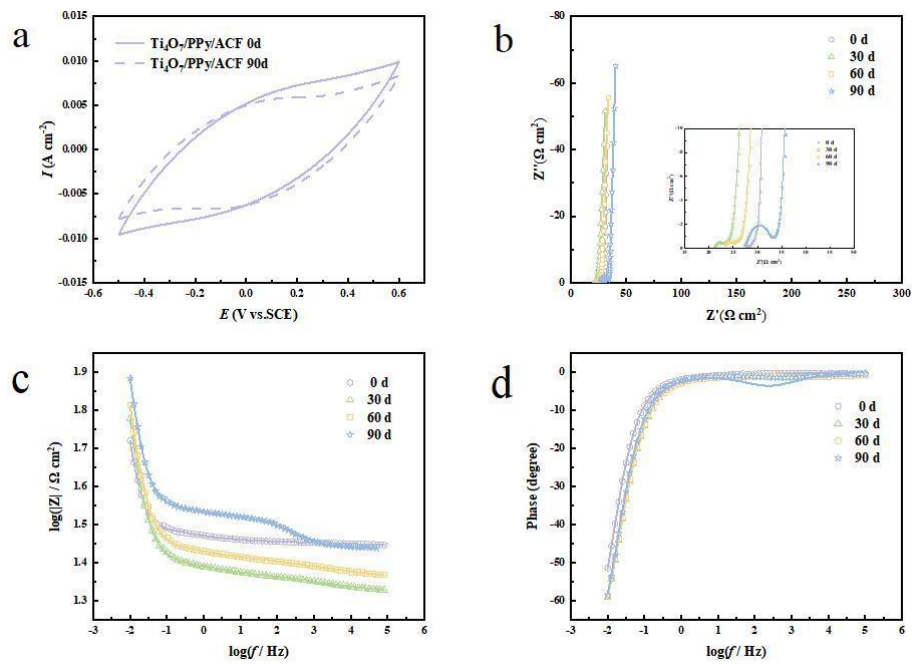


Fig.1. (a) CVs, (b) Nyquist plots, and (c,d) Bode plots of $(\text{Ti}_4\text{O}_7+\text{PPy})/\text{ACF}$ after immersion in SBF solution for different times.

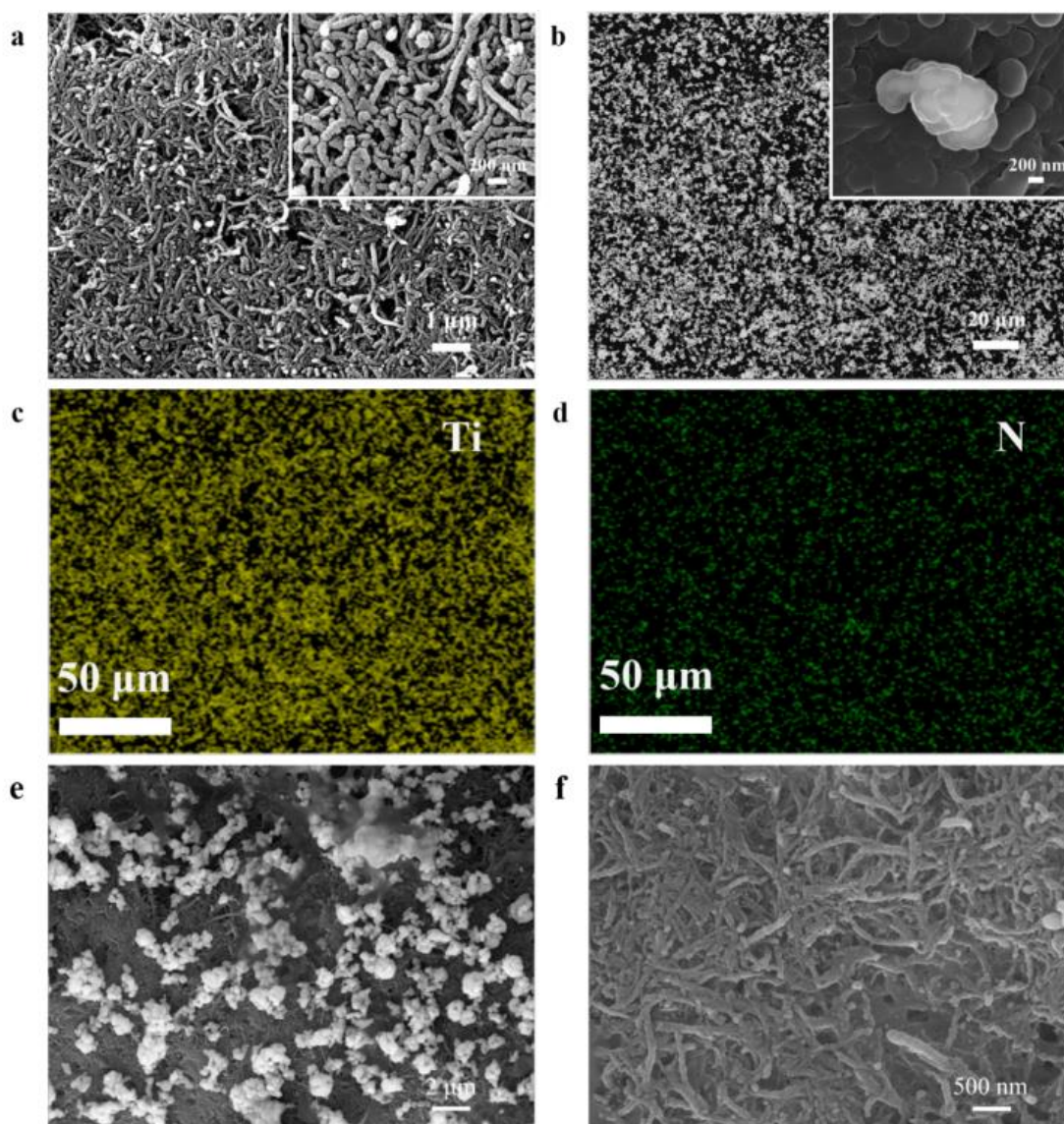


Fig.2. SEM morphologies of (a) PPy/ACF, (c) Ti₄O₇+PPy/ACF, (c~d) EDX mappings of Ti₄O₇+PPy/ACF, and (e~f) after 90 days of soaking.

Keywords: Polypyrrole; Carbon foam; Ti₄O₇; Stability

Reference

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