Materials Letters 165 (2016) 71–74

Contents lists available at ScienceDirect

Materials Letters

journal homepage: www.elsevier.com/locate/matlet

Synthesis and high-performance microwave absorption of graphene foam/polyaniline nanorods

Yan Wang*, Xinming Wu, Wenzhi Zhang

School of Material and Chemical Engineering, Xi'an Technological University, Xi'an 710129, PR China

ARTICLE INFO

Article history:
Received 20 October 2015
Received in revised form
18 November 2015
Accepted 25 November 2015
Available online 27 November 2015

Keywords:
Carbon materials
Polymers
Dielectrics
Microwave absorption properties

ABSTRACT

A novel structure of graphene foam/PANI nanorods (GF/PANI nanorods) were fabricated by a two step method, including synthesize of graphene foam using self-assembly method and in situ polymerization of PANI nanorods on the surface of graphene foam. The structure of GF/PANI nanorods was characterized by FTIR, XRD, Raman spectroscopy, XPS and FESEM. The electromagnetic parameters indicate that GF/PANI nanorods exhibit high-performance microwave absorption properties compared with sole graphene foam. The maximum R_L is up to −52.5 dB at 13.8 GHz and the absorption bandwidths exceeding −10 dB are 12.2 GHz with a thickness in the range of 1.5–4 mm. The possible absorption mechanism of GF/PANI nanorods was also investigated in detail. Our results indicate that the deposition of PANI nanorods on graphene foam is an efficient way to synthesize excellent microwave absorbers.

1. Introduction

Electromagnetic waves radiation has caused environmental pollution, not only in influencing the operation of electronic devices, but also being harmful to the health of human beings. Therefore, a high-performance microwave absorption material with a broadband ability is highly demanded to eliminate unnecessary electromagnetic waves radiation [1]. Recently, graphene has grabbed considerable attention for microwave absorption due to the residual defects, the large aspect ratio, interfacial polarizations and high conductivity [2,3]. However, sole graphene suffers from impedance mismatching due to good electrical conductivity [4]. Recently, graphene has to be blended with other materials to improve the microwave absorption properties, such as porous Fe_3O_4–graphene [5], $NiFe_2O_4$ nanorod-graphene [6], Co_3O_4-graphene [7], MWCNT-graphene [8], carbonyl iron–graphene [9], PANI nanorod-graphene [10,11] and CuS–graphene [12], but these researches are mostly focus on graphene sheets. Lately, significant progress has been made toward investigating the synthesis of graphene foam (GF) from graphene sheets. Using self-assembly method, the free-standing graphene foam has been synthesized [13], which paves the way for the exploitation of graphene foam as microwave absorption material. However, to the best of our knowledge, microwave absorption performance of graphene foam decorated with PANI nanorods has never been reported.

In this work, we directly grow PANI nanorods on the surface of GF by an in situ polymerization process. Structural and morphological of GF/PANI nanorods have been investigated. The maximum R_L of GF/PANI nanorods is up to −52.5 dB at 13.8 GHz and the absorption bandwidths exceeding −10 dB are 12.2 GHz with a thickness in the range of 1.5–4 mm.

2. Experimental

Graphene oxide (GO) was synthesized by Hummers method [14]. GF/PANI nanorods were prepared as follows: Firstly, GF was synthesized according to the previous method [15]. Secondly, 0.2 g GF was dispersed in 200 mL HCl solution (1 mol/L) by sonication treatment and the mixture was cooled down to 0–5 °C under stirring, then 0.2 mL aniline was added and stirred for 30 min, ammonium persulfate (0.25 g) dissolved in 5 mL HCl solution (1 mol/L) was added and the mixture solution was stirring for 24 h at 0–5 °C. The precipitate was washed by distilled water, and dried at 60 °C for 24 h.

FTIR was characterized by NICOLET iS10. The crystal structure was characterized by X-ray diffraction (Philips-PW3040/60). Raman spectroscopy was carried out on a Renishaw in Via Raman Microscope. The chemical states were investigated by X-ray photoelectron spectroscopy (XPS, PHI 5300X). The morphology was characterized by field emission scanning electron microscope (FESEM, Quanta 600FEG). The electromagnetic parameters were measured by a HP8753D vector network analyzer.

* Corresponding author.
E-mail address: wangyan287580632@126.com (Y. Wang).

http://dx.doi.org/10.1016/j.matlet.2015.11.116
0167-577X/

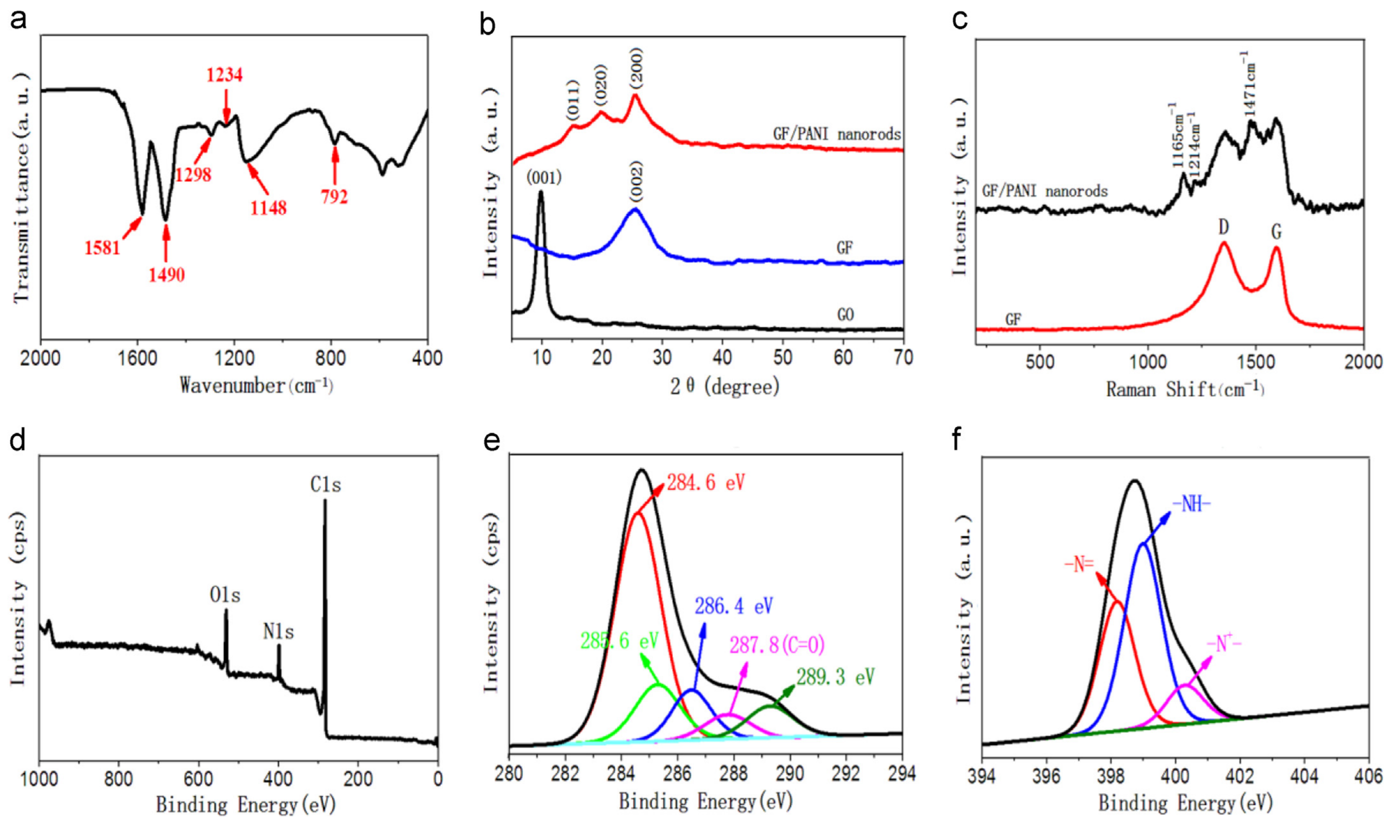

Fig. 1. FTIR spectra (a) of GF/PANI nanorods, XRD patterns (b) of GO, GF and GF/PANI nanorods, Raman spectra (c) of GF and GF/PANI nanorods, XPS spectra (d), C1s (d) and N1s (e) of GFs/PANI nanorods.

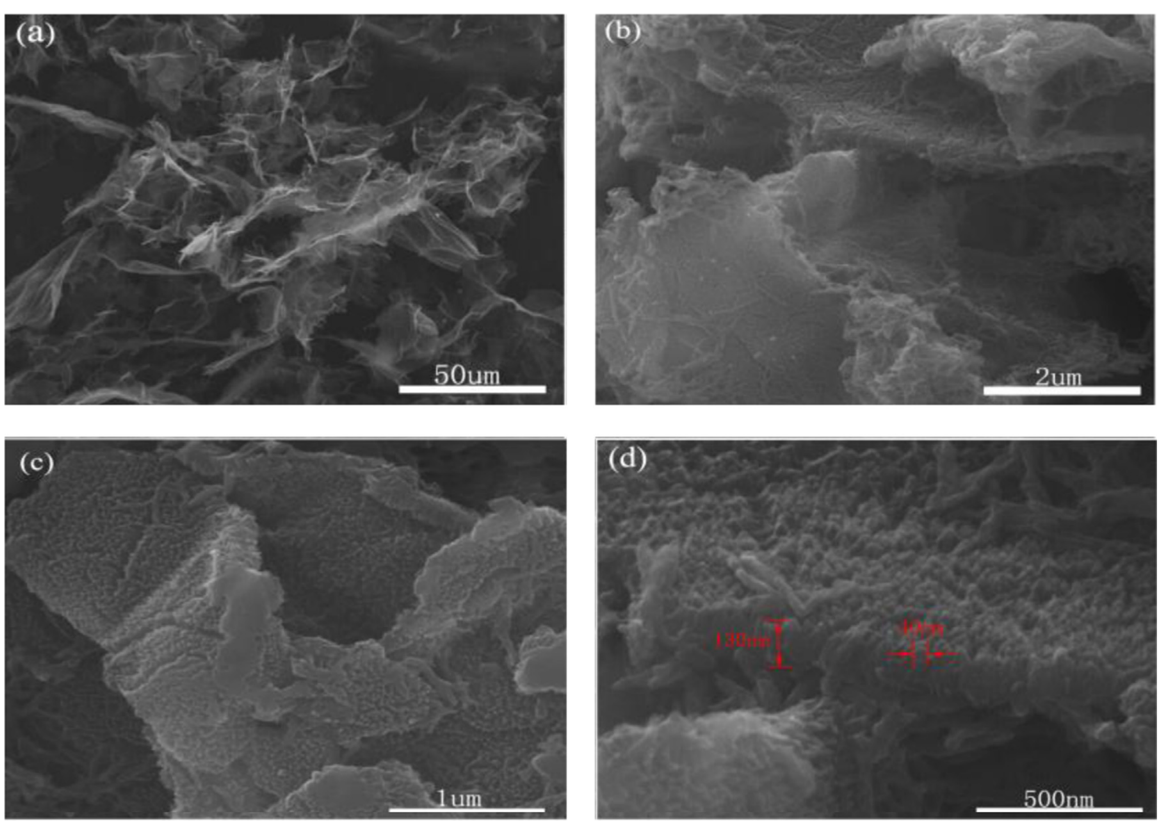

Fig. 2. FESEM images of GF (a) and GF/PANI nanorods (b–d).