Applied Surface Science 257 (2011) 5270–5273

Contents lists available at ScienceDirect

Applied Surface Science

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

About graphene ribbons development in laser synthesized nanocarbon

L. Gavrila Florescu [a], E. Vasile [b], I. Sandu [a], I. Soare [a], C. Fleaca [a], R. Ianchis [c], C. Luculescu [a], E. Dutu [a], R. Birjega [a], I. Morjan [a], I. Voicu [a,*]

[a] National Institute for Lasers, Plasma and Radiation Physics, P.O. Box MG-36, Bucharest, Romania
[b] METAV, 16-18 Zapada Mieilor St., 71529 Bucharest, Romania
[c] Institute of Chemical Research, 202 Splaiul Independentei, CP 15-159, 76250 Bucharest, Romania

ARTICLE INFO

Article history:
Available online 16 November 2010

Keywords:
Laser pyrolysis
Graphene
Carbon nanopowders

ABSTRACT

The work presents preliminary studies with the goal to extend the share of long graphene ribbons in laser-synthesized carbon black. Investigations revealed the existence, as a major constituent, of graphene ribbons composed of up to 10–15 graphene layers, spaced at ~0.35–0.37 nm and of tens of nanometres in length. The samples used to study the development of this specific structure were obtained from sensitized acetylene-based mixtures and the experiments were performed following the variation of both the experimental parameters and gas composition.

© 2010 Elsevier B.V. All rights reserved.

1. Introduction

Unusual properties of nanomaterials can arise because they can possess a large volume of interfacial matrix with properties different from the bulk, which, by suitably tailoring the properties, may provide the opportunity for multifunctionality [1]. Graphene sheets are predicted to possess remarkable electronic, thermal or mechanical properties; their fracture strength should be comparable to that of nanotubes [2]. As one-dimensional stripes of graphene, the properties of the graphene ribbons are depending on their structural characteristics [3]. A possible route to harnessing these properties for applications would be to incorporate them in a composite material. Through the variation of gas composition and experimental parameters, the method of laser-induced pyrolysis allows generation of carbon nanoparticles with different morphologies providing useful functional properties. Preliminary tests conducted on some polymer-based composites with enhanced mechanical properties, in which nanocarbon concentration was present at up to max. 5% in weight suggest that these nanoribbons could be placed among the carbon nanostructures with promising results [4]. The work is proposing to investigate the possibilities of changing, through laser-induced pyrolysis, the morphology of the carbon nanopowders in order to have an ultimate material with a higher content of graphene ribbons with foreseen structure.

2. Experimental

The synthesis method of carbonaceous materials by laser-induced pyrolysis uses hydrocarbons, either in resonant processes (ethylene, butadiene) or non-resonant ones (acetylene, benzene), when the negligible absorption of the incident radiation by the precursors requires the addition of an energy transfer gas, which can either react or interfere.

Samples were prepared by using a continuous wave CO_2 laser, emitting on the 10P20 line (944 cm^{-1}) with a power density of 1.75×10^4 W/cm^2 (laser beam of 4 mm diameter) and acetylene/SF_6, ethylene/SF_6 or acetylene/ethylene gas mixtures with a total flow of 300 sccm and (C/F) atomic ratios ranging from 0.2 to 9; the working pressure was maintained at 7.5×10^4 Pa. The powder characteristics were investigated by electron microscopy and related techniques, X-ray diffraction (XRD) spectroscopy and Raman spectrometry. The complementary data regarding the particles' size and aggregation of the analysed samples were obtained by Dynamic Light Scattering (DLS) investigations.

3. Results and discussions

Laser-induced pyrolysis of pure hydrocarbons leads to carbon nanoparticles with turbostratic structure [5] while the controlled addition of an oxidizer in the reactive gas mixture could change the structure to the fullerene-like one [6]. The particle's size distribution could be fitted with a log-normal function and covers a relatively narrow spread in the range of 10–50 nm. Investigations by Dynamic Light Scattering showed the notable existence of aggregates with dimensions between 150 and 650 nm. The

* Corresponding author. Tel.: +40 21 4574489; fax: +40 21 457 42 43.
E-mail address: ionvoicu2001@yahoo.com (I. Voicu).

0169-4332/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.apsusc.2010.11.036

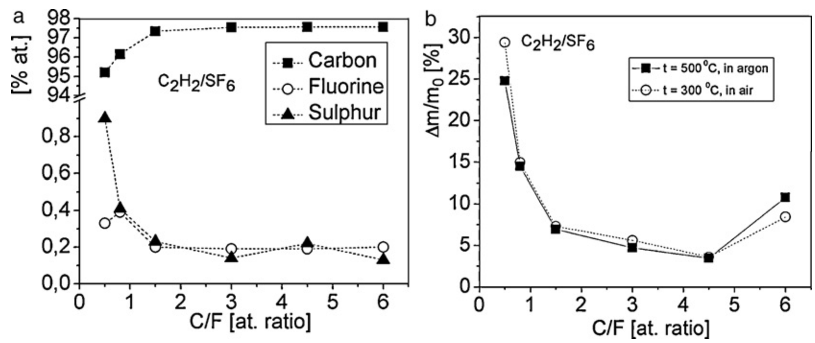

Fig. 1. The evolution of carbon, sulphur and fluorine content (a) and the variation of the relative mass losses (b) in C_2H_2/SF_6 samples with different C/F atomic ratio.

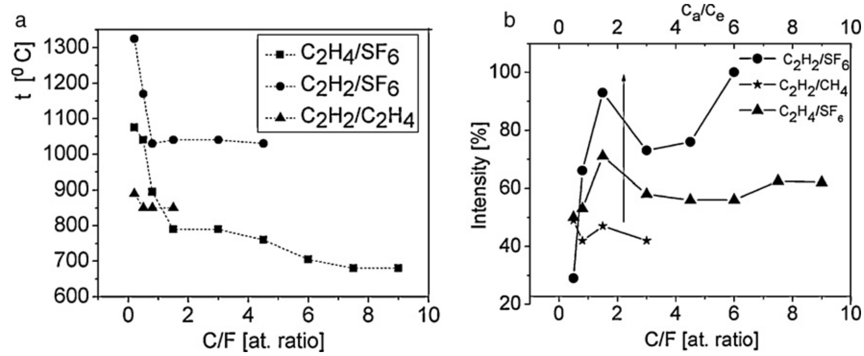

Fig. 2. Flame temperatures (a) and intensity of (0 0 2) peak in corresponding XRD patterns (b) for samples synthesized from C_2H_2/SF_6, C_2H_2/C_2H_4 and C_2H_4/SF_6 with different sensitizer's concentration.

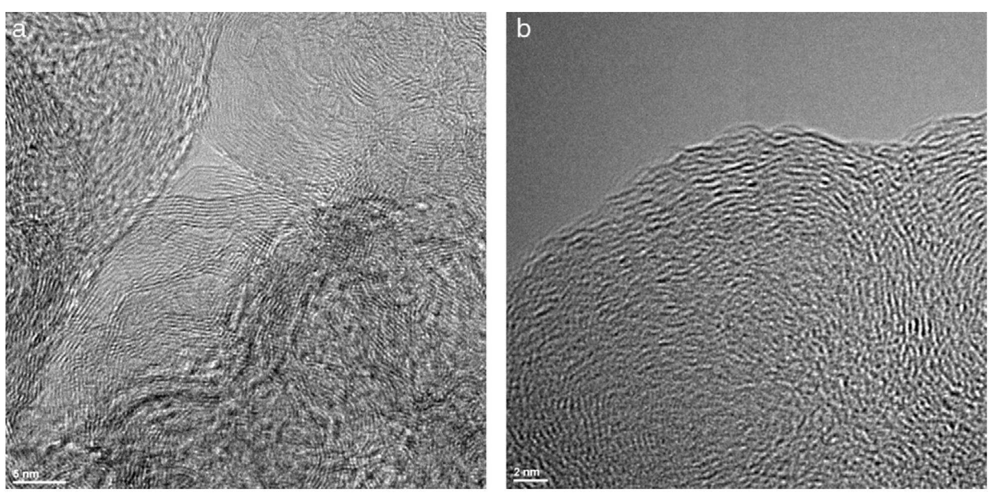

Fig. 3. HREM images of a sample: (a) synthesized from a C_2H_2/SF_6 gas mixture (C/F at. = 3) showing well-developed graphene bands, (b) C_2H_4/SF_6 (C/F at. = 3), showing a rather turbostratic structure.

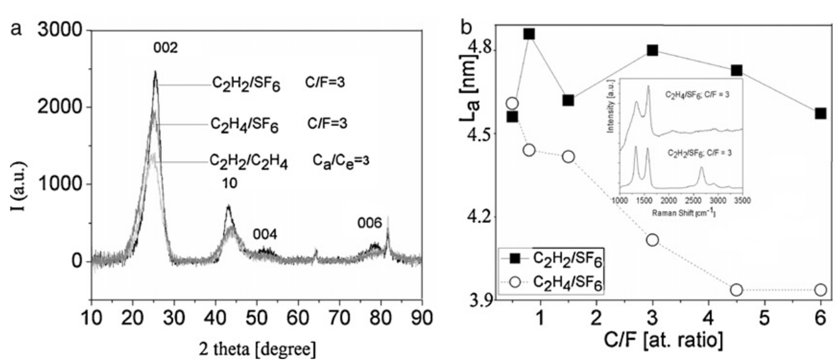

Fig. 4. (a). XRD patterns of samples synthesized from C_2H_2/SF_6, C_2H_2/C_2H_4 and C_2H_4/SF_6 gas mixtures; (b). The variation of L_a [nm] as a function of C/F at ratio for samples from C_2H_2/SF_6 and C_2H_4/SF_6 gas mixtures; the inset shows Raman spectra of both samples.

Download English Version:

https://daneshyari.com/en/article/5364362

Download Persian Version:

https://daneshyari.com/article/5364362

Daneshyari.com