# Preparation of N-Functionalized Graphitic Carbon by Catalyst-Free Pyrolysis of the Biomass Wastes Chitosan and Chitin

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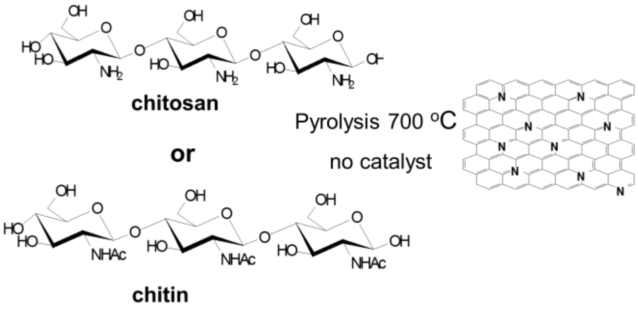
## 1 Introduction

Formaldehyde (FA) is a volatile organic compound considered one of the largest pollutants in indoor environment. Of predominant anthropogenic origin, it is a major irritant to the eyes and pharynx. However, the major concern of FA exposure is related to IARC classification on group 1 – carcinogenic to humans - which raised great public awareness. In this context, developing a new material for FA adsorption has a global interest due to the large industrial use in several segments. Therefore, here we propose the use of a new carbonaceous material containing Nitrogen derived from the biomass wastes Chitosan and Chitin for the detection and adsorption of formaldehyde. Favorable carbonyl–adsorbent interaction in the case of formaldehyde can be expected due to the presence of the N-functionalized graphitic carbon.




Following green chemistry principles, avoiding any unfriendly metal catalyst and using a single carbon and nitrogen source from inexpensive biomass wastes, graphitic carbons were produced upon pyrolysis of chitosan and chitin at 700 °C.

## 2 Methodology

The synthesis of the graphitic carbons was carried out at 700 oC using either chitosan or chitin as a carbon source. In a typical synthesis, 1.00 g of chitosan or chitin was heat-treated in a furnace, under air, at 700 oC with a ramp time of 5 oC / min. Microelemental analysis was performed with a Vario Micro cube elemental analyzer. Fourier-Transform Infrared Spectroscopy (FTIR) was performed with a Varian 600 FTIR spectrometer with the number of scan times of 256. Raman spectroscopy was performed with WITec and using a 532 nm laser excitation source. X-Ray Diffraction was performed with a PANalytical X'Pert diffractometer using a angular detector.

Formaldehyde was detected and quantified as described by the NIOSH FORMALDEHYDE: METHOD 2016, Issue 2, 2003.

## 3 Results

| Sample | Weight (mg) | N [%] | C [%] | H [%] | O [%] |
|---|---|---|---|---|---|
| Chitosan | 1.937 | 7.67 | 40.92 | 7.44 | 43.96 |
| Chitosan T700 | 2.059 | 11.22 | 76.03 | 3.04 | 9.71 |
| Chitin | 1.896 | 7.21 | 42.73 | 7.66 | 57.60 |
| Chitin T700 | 2.028 | 10.49 | 76.11 | 2.97 | 10.42 |

Table 1 – Elemental analysis: Chitosan, chitin and pyrolyzed samples at 700 ° C.

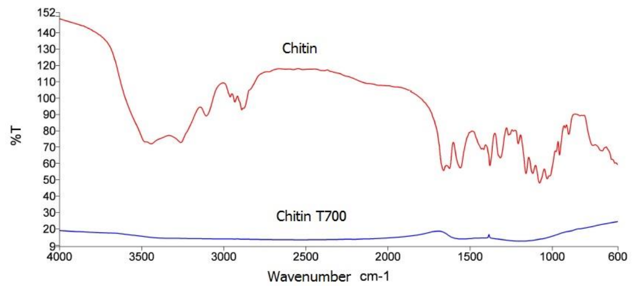



Fig.1 - FTIR spectra of commercial chitin and pyrolysed at 700°C

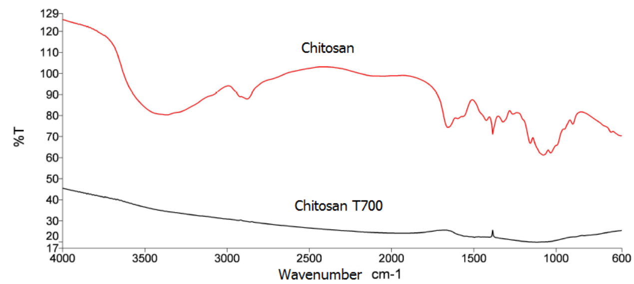



Fig.2 - FTIR spectra of commercial chitosan and pyrolyzed at 700°C

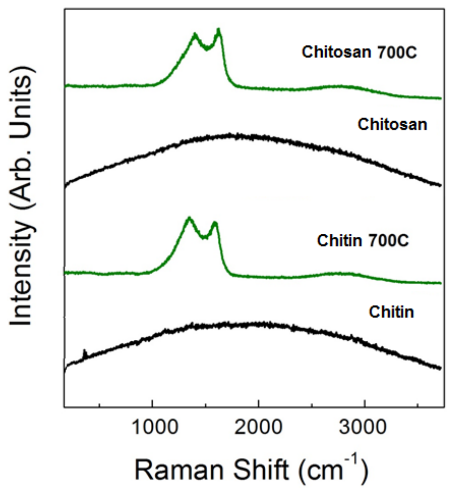



Fig.3 – Raman spectra of commercial chitin and chitosan and pyrolysed at 700°C. Spectra were obtained using a Raman spectrometer with a 532 nm laser excitation source.

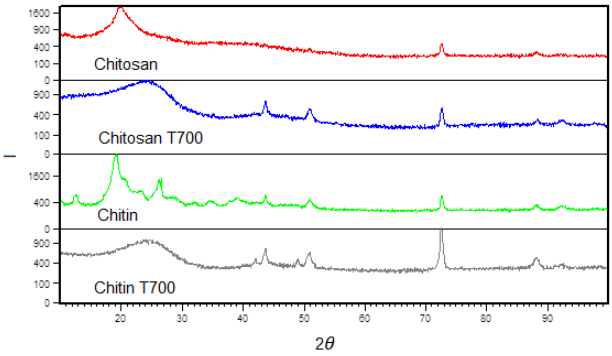



Fig. 5 – X-ray diffraction results of commercial chitin and chitosan and pyrolyzed at 700°C.

## 4 Conclusions

In conclusion, pyrolysis of the biomass wastes chitin and chitosan at 700 °C led to the formation of carbon materials which were characterized by Elemental Analysis, FTIR and Raman Spectroscopy and X-ray diffraction. From the later, the carbon material structures clearly show crystalline, nanocrystalline and amorphous phases. The preliminary results of the adsorption experiments confirm that formaldehyde can be efficiently adsorbed on these materials and could be used as a possible alternative for adsorption of formaldehyde in the occupational environment.

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