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

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Summary

1- Abstract

2- Precursor substance

3- Elemental analysis

4- Scanning Electron Microscopy

5- Fourier Transform Infrared Spectroscopy

6- Espectroscopia Raman

7- X-ray diffraction

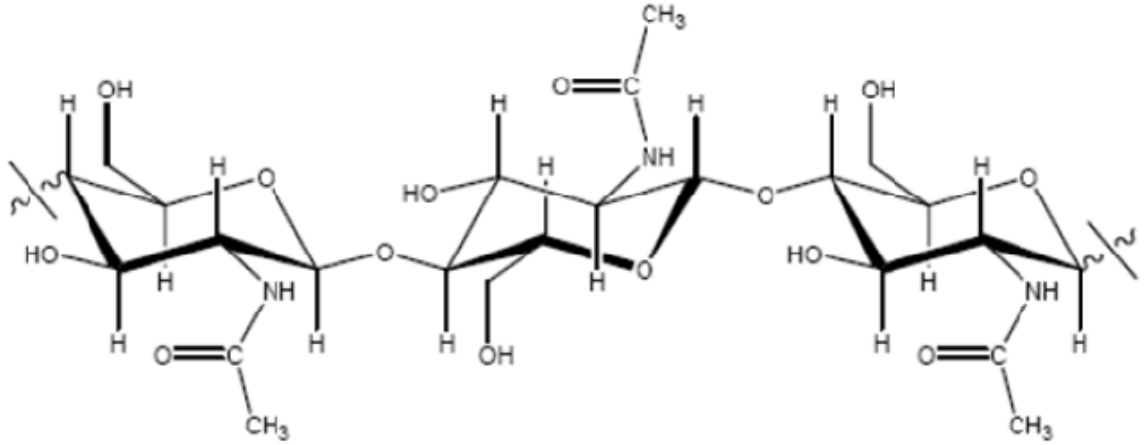
8- Adsorption Test

9- Conclusion

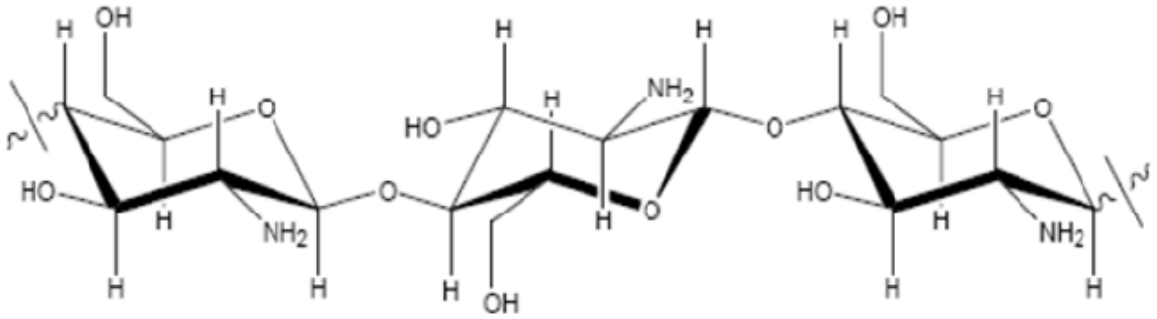
Abstract

Formaldehyde (FA) is a volatile organic compound considered one of the largest pollutants in indoor environments. Of predominant anthropogenic origin, it is a major irritant to the eyes and pharynx. The major concern of FA exposure, however, 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 detection has a global interest due to the large industrial use in several segments. Therefore, here we propose the use of a new carbonaceous material of N atoms on the from the biomass wastes Chitosan and Chitin for the detection and adsorption of formaldehyde. Favorable carbonyl–chemical adsorbent interactions with formaldehyde can be expected due to the presence carbon when using N-functionalized graphitic carbon. Following green chemistry principles, avoiding any unfriendly metal catalyst and using a single carbon and nitrogen source of inexpensive biomass wastes, chitosan and chitin will be muffle furnace heated or pyrolyzed.

Precursor substance



Chitin

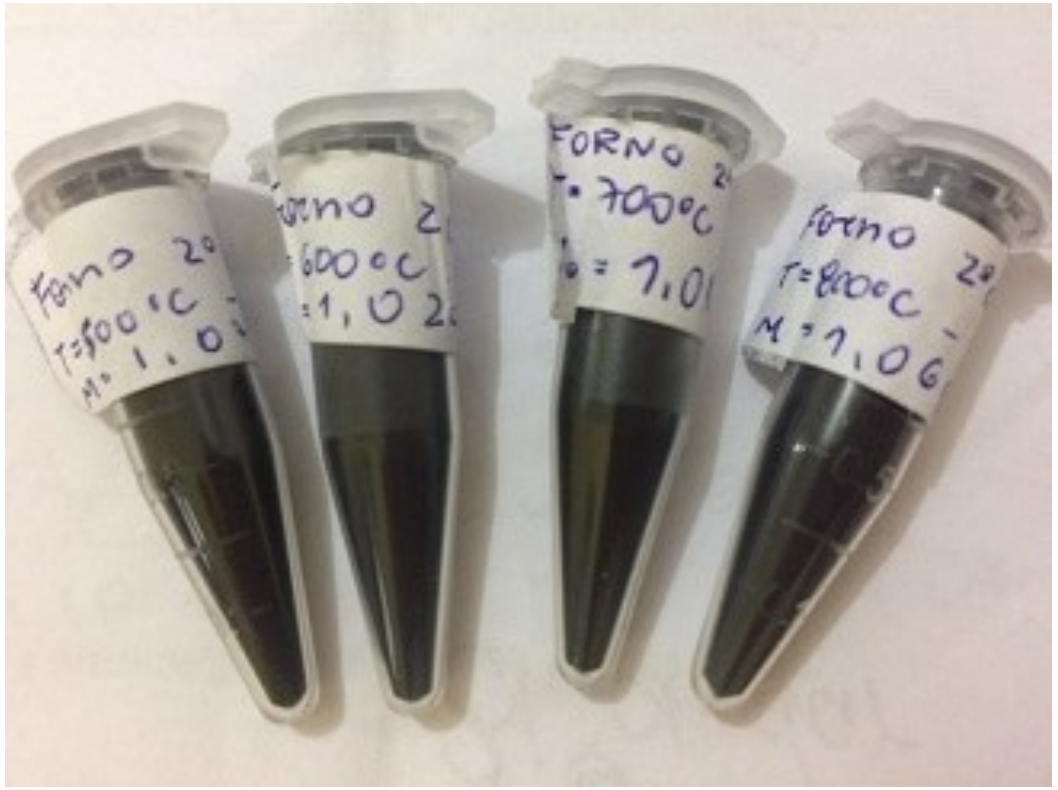


Chitosan

Chemical structure of chitin and chitosan

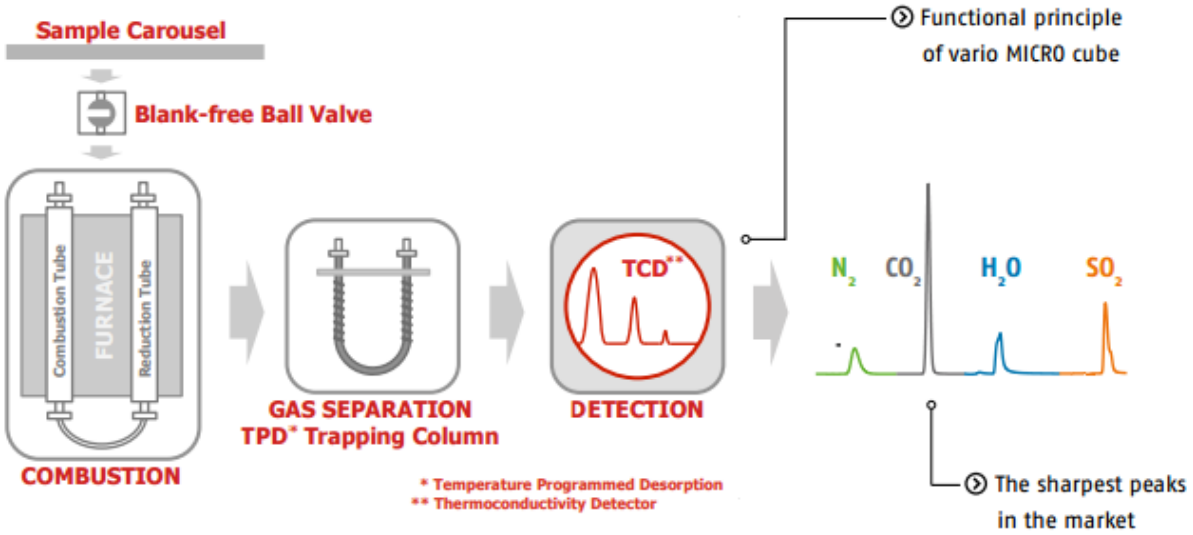
Chitin and chitosan pyrolyzed.

Chitin



Chitosan

Elemental analysis: N,C,H,S.



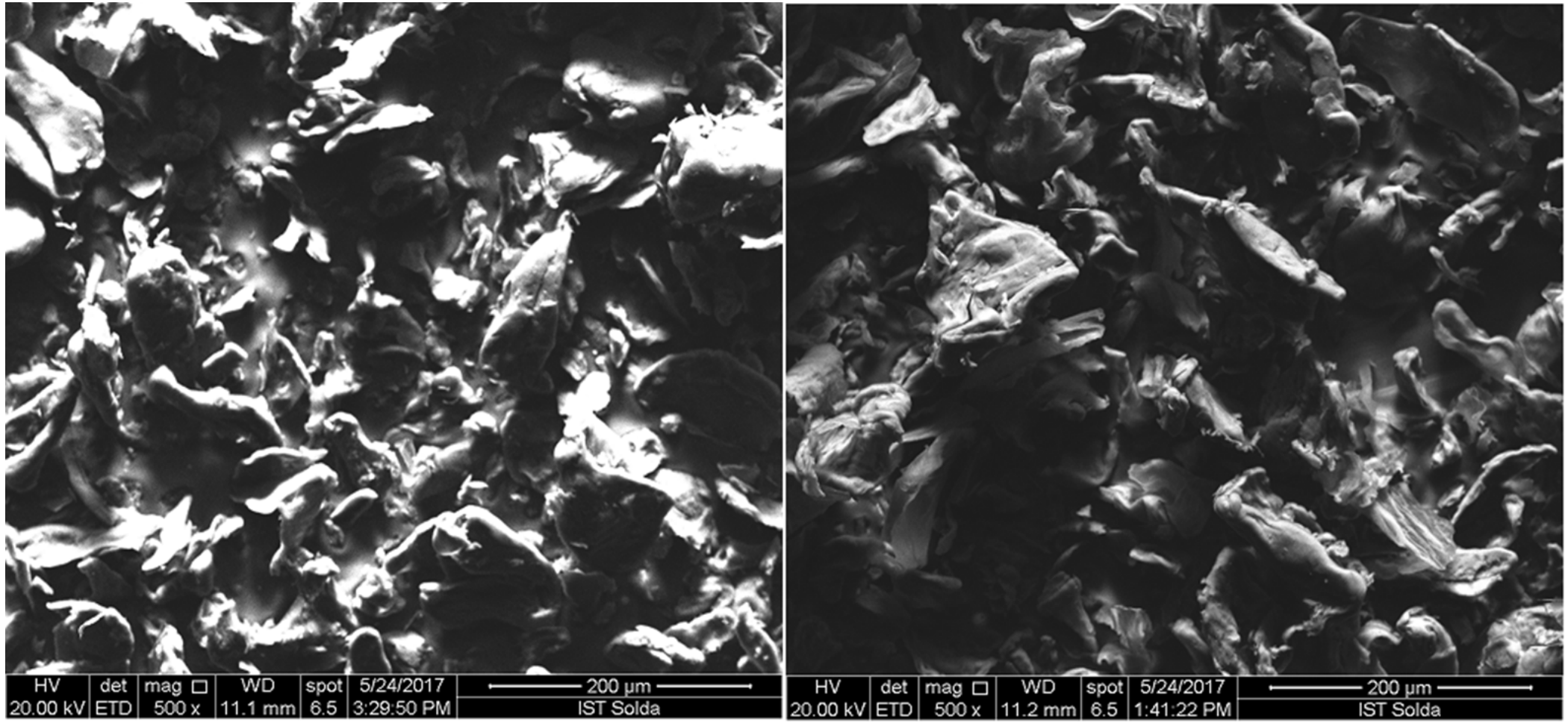
Substance	Weight (mg)	N [%]	C [%]	H [%]	S [%]
Chitin	1.8960	7.21	42.73	7.669	0.042
Chitin500	2.0870	10.31	68.43	3.221	0.015
Chitin600	1.9800	10.02	70.08	3.877	0.000
Chitin700	**2.0280**	**10.49**	**76.11**	**2.975**	**0.020**
Chitin800	1.9480	7.48	78.89	2.642	0.009

Tab. 1 - Results of the chitin elemental analysis

Substance	Weight (mg)	N [%]	C [%]	H [%]	S [%]
Chitosan	1,937	7.67	40.92	7.444	0.405
Chitosan 500	1,959	13.13	72.76	4.122	0.048
Chitosan 600	1,988	12.03	72.86	3.282	0.033
Chitosan 700	**2,059**	**11.22**	**76.03**	**3.040**	**0.036**
Chitosan 800	1,953	9.48	76.64	2.629	0.062

Tab. 2 - Results of the chitosan elemental analysis

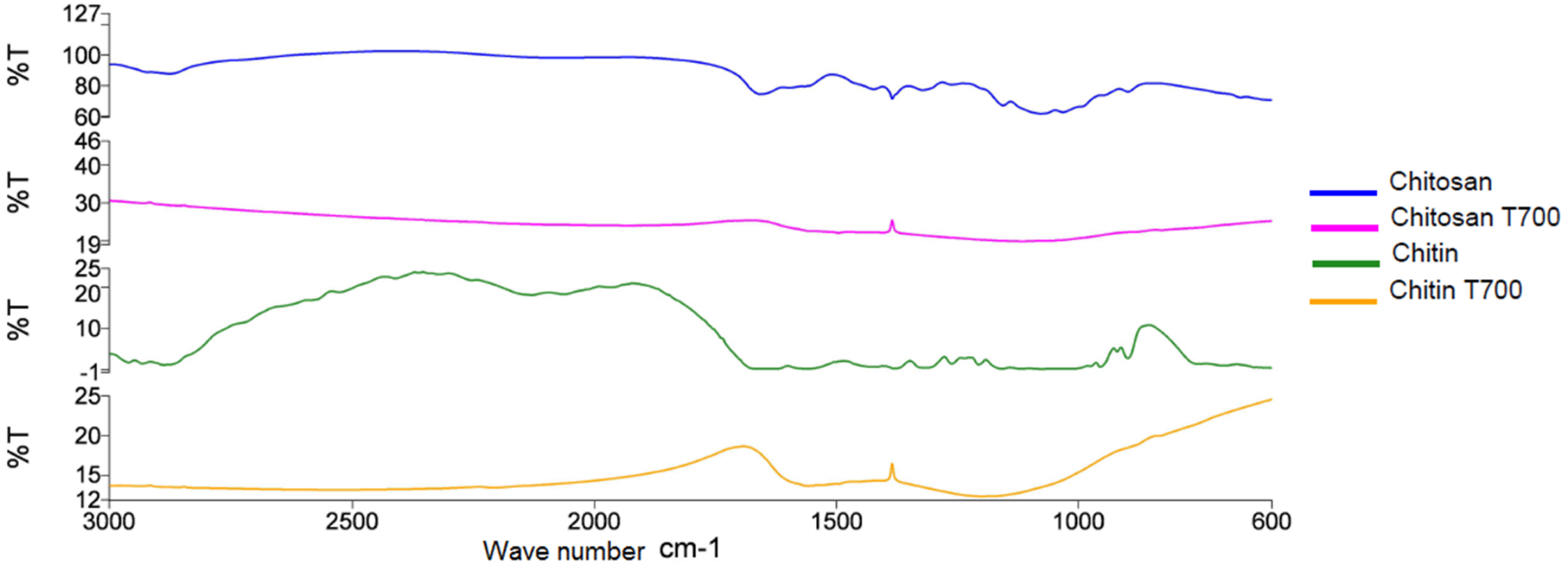
Scanning Electron Microscopy - SEM



a) b)

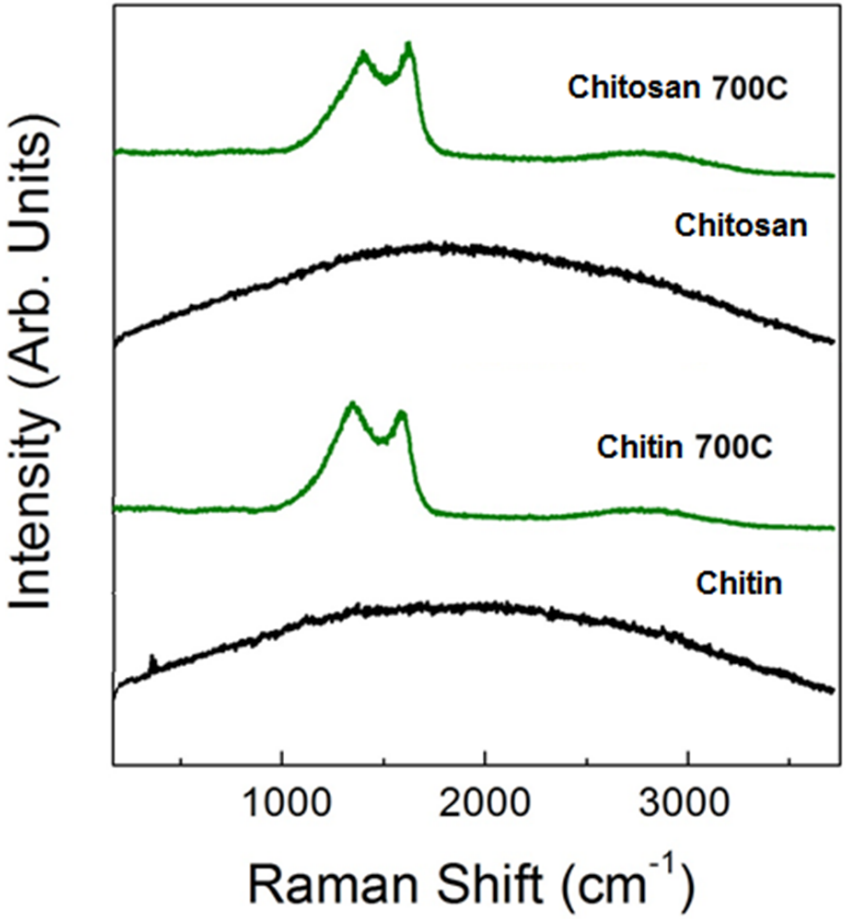
Fig. 1– SEM image (a) chitosan, b) Chitin pyrolyzed ate 700° C

Fourier Transform Infrared Spectroscopy - FTiR



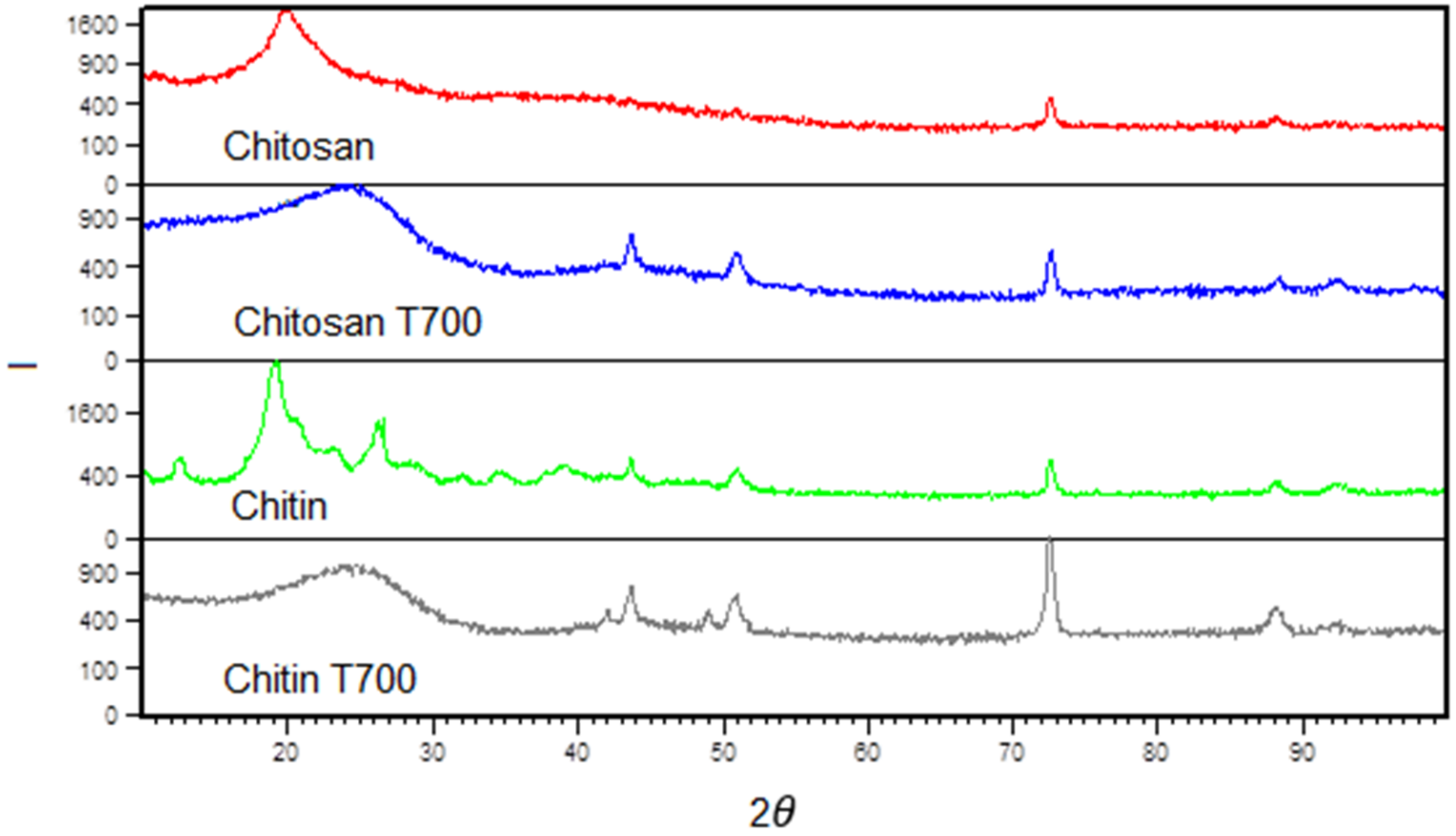
FTiR spectra of commercial chitin and chitosan and pyrolysed chitin and chitosan at 700°C.

Espectroscopia Raman



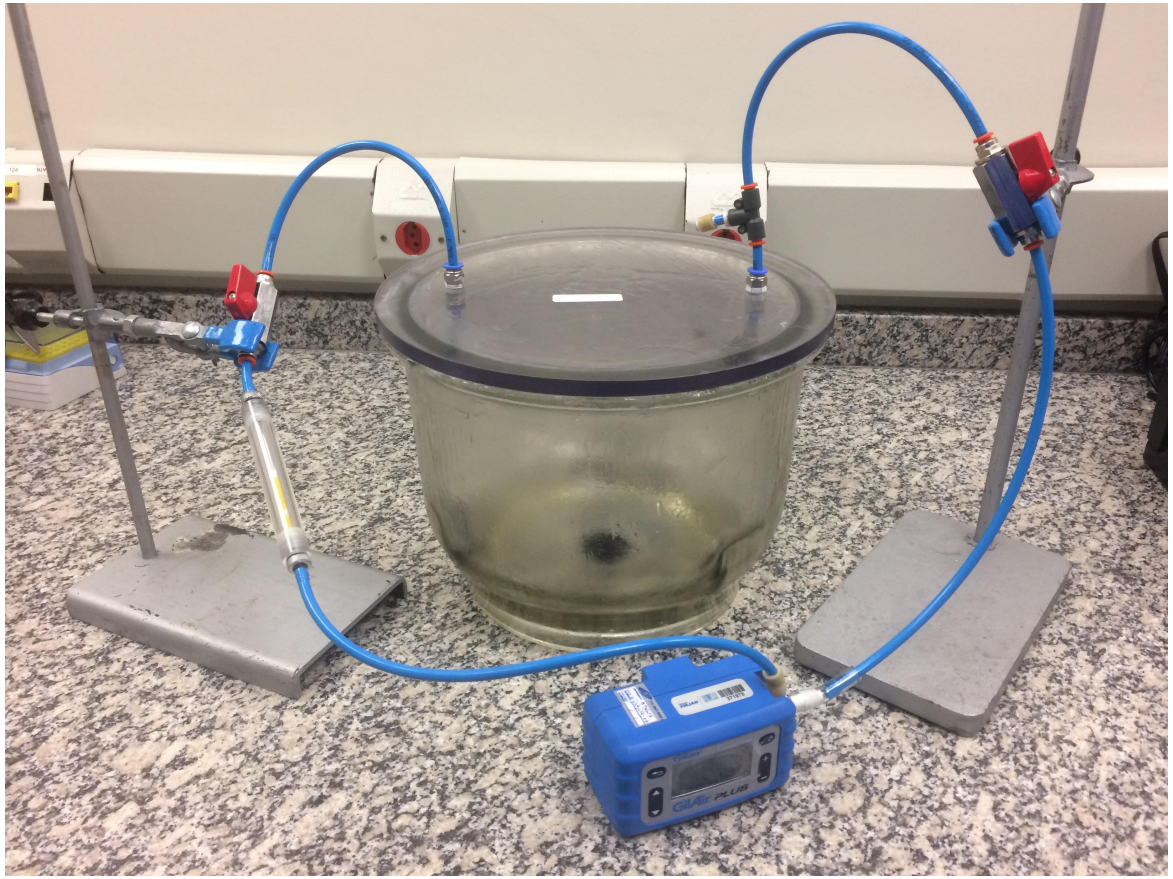
Raman spectra of commercial chitin and chitosan and pyrolysed chitin and chitosan at 700°C. Spectra were obtained using a Raman microscope with a 532 nm laser excitation source

X-ray diffraction



X – ray diffraction of commercial chitin and chitosan and pyrolysed chitin and chitosan at 700°C.

Adsorption Test - Preliminary results



Second adsorption test: solutions with different concentrations of formaldehyde.

Condições iniciais ≈ 150 ppm

Exposure time	Concentration Form-DNPH chromatograph (mg / L)	Mass of formaldehyde collected in the chamber (mg)	Concentration Formaldehyde in the chamber (ppm)
5h	246,57	0,1057	42,81

The adsorption on chitosan of approximately 70%

Conclusion

Evaluating the characterization and results of the adsorption test we conclude that the material adsorbs formaldehyde, as initially proposed.
The next step will be to complete the formaldehyde adsorption methodology in the gaseous form, and to test the adsorption efficiency.
Finally, implement a protective mask for safety in the occupational environment.

Thank you!