Lina Cai

Factors affecting carbon filter adsorption in cigarette smoke

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Factors Affecting Carbon Filter Adsorption in Cigarette Smoke

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Outline

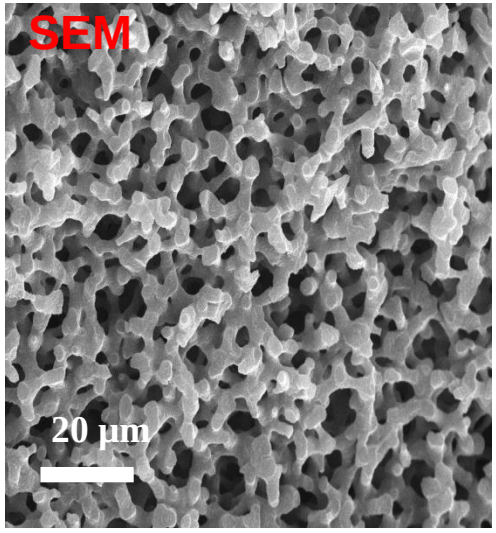
- Background
- Experimental design
- Results and discussion
- Conclusions

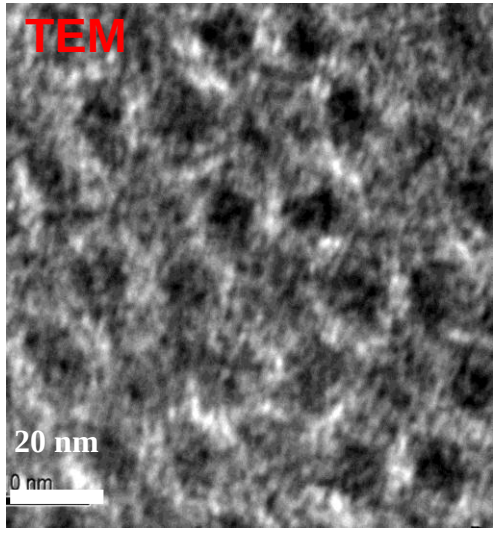
Background

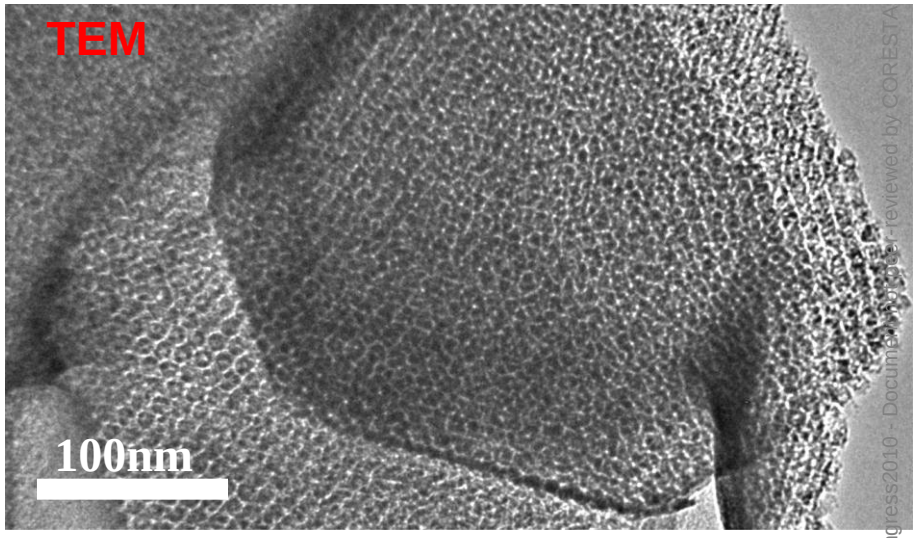
Porous carbon can be used as a very efficient adsorbent in the cigarette filter

Because of

- **Good absorbability**
- **Excellent thermal stability**
- **Variable surface chemistry**







Research motivations

- To investigate the contribution of tar deposition to decreasing carbon activity in a cigarette filter

- To establish the relative constructions towards porous carbon deactivation from the smoke particulate phase and the smoke vapor phase

- To find out which carbon parameters give the greatest adsorption in the cigarette filter and which types of compounds are adsorbed

Experimental design

cigarette

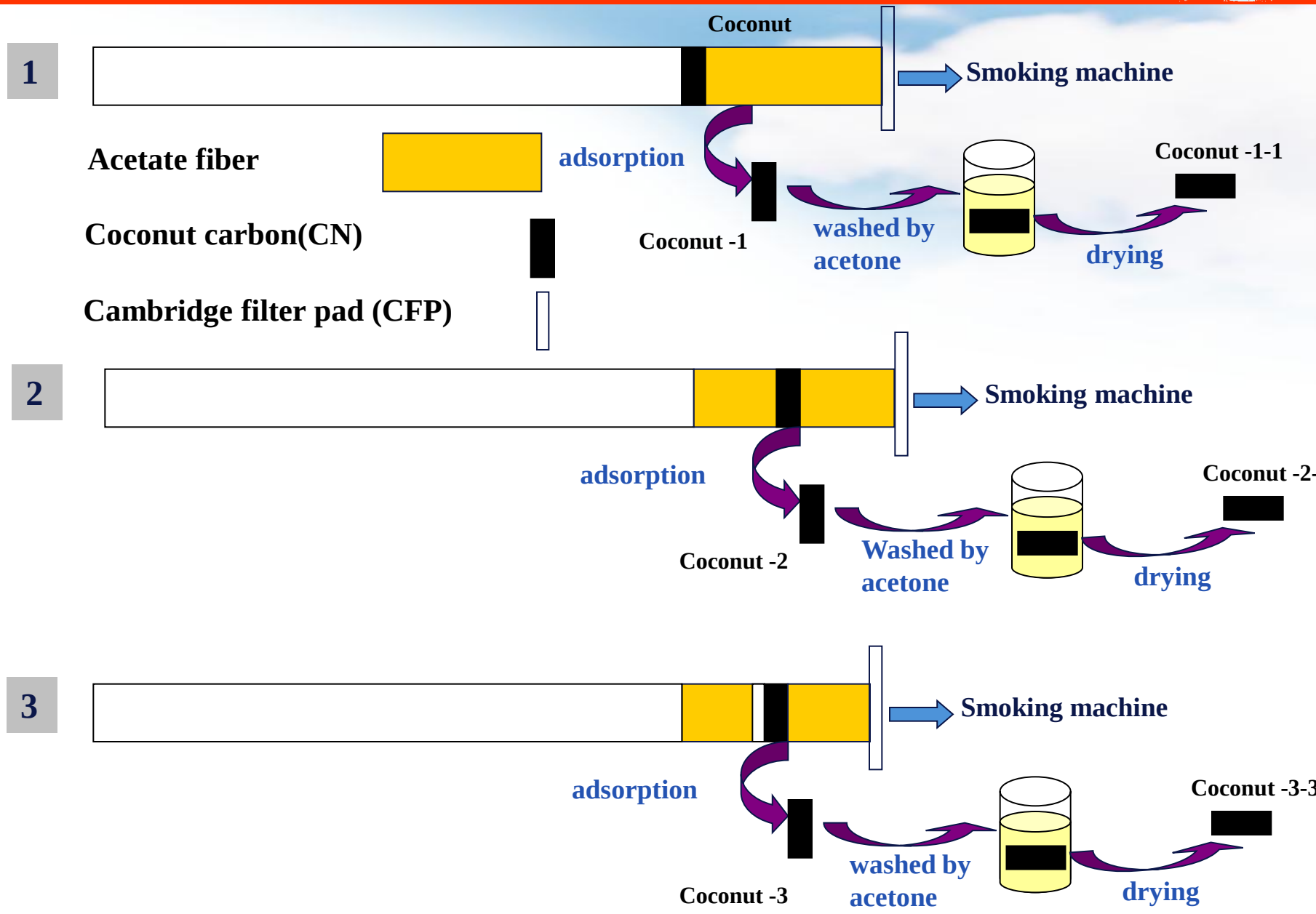
self-made filter

pad

gasbag

smoking engine

Experimental design



Characterization

- **Nitrogen sorption analysis**

  To get the pore structure information of the carbon

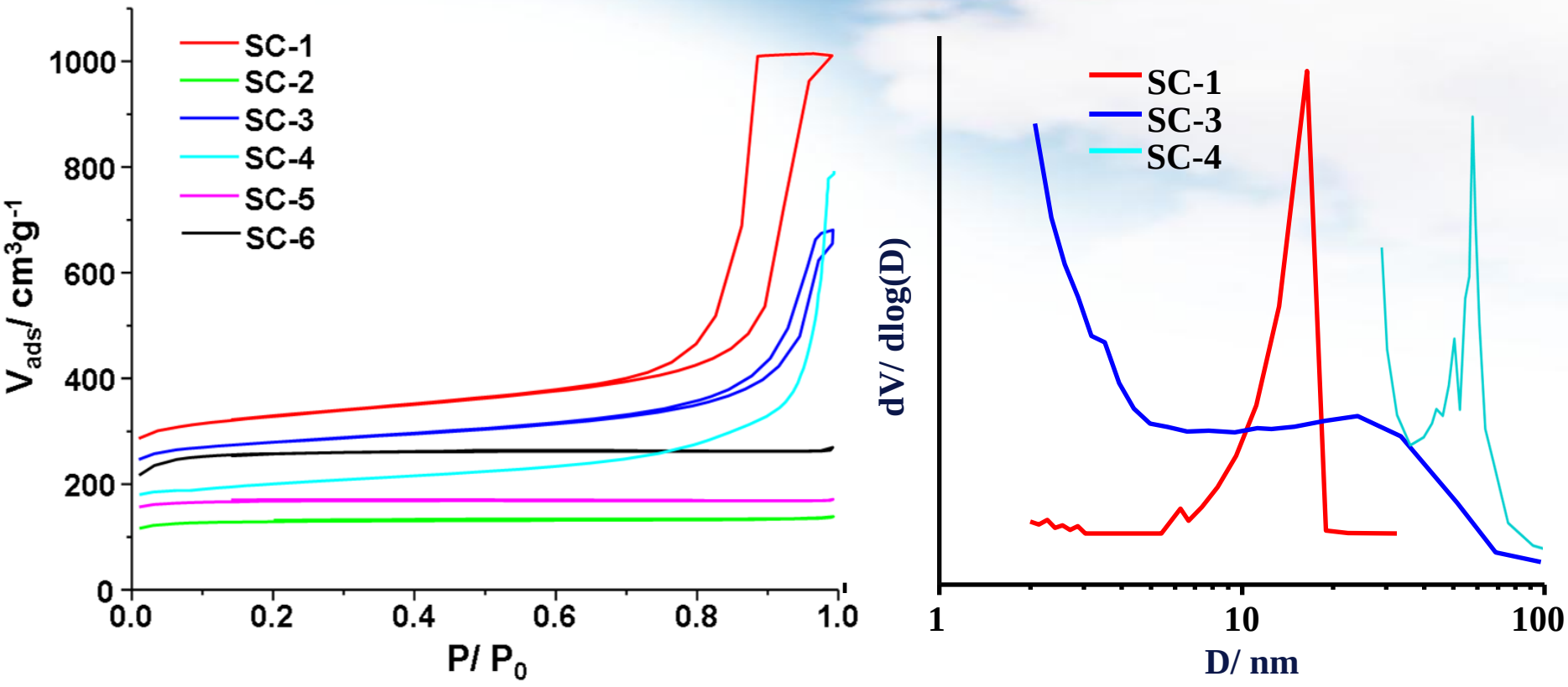
- **Thermogravimetric analysis**

  To get the thermal information of the carbon

- **Gas chromatography analysis**

  To get the absorbability information of the carbon

Results and discussion



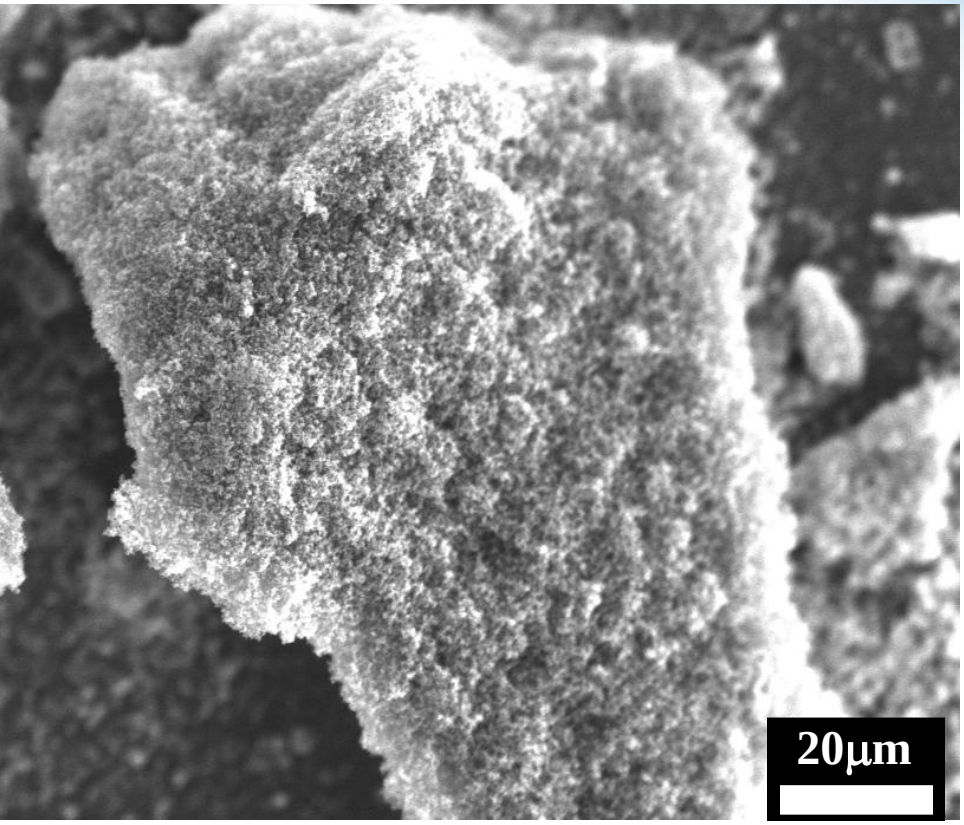
Nitrogen sorption isotherms and pore size distributions of the porous carbons

Texture parameters of the carbons

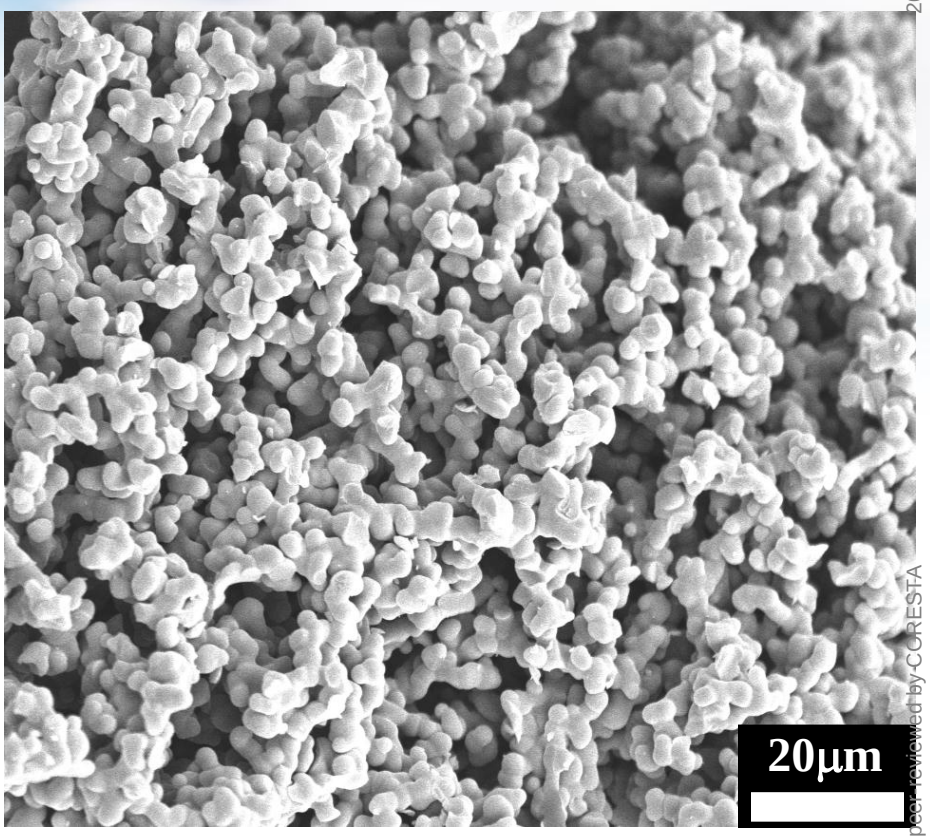
Sample	S_{BET} (m^2/g)	V_{total} (cm^3/g)	V_{mic} (cm^3/g)	D_{peak} (nm)
SC-1	590	1.12	0.16	13.2
SC-2	440	0.22	0.19	-
SC-3	610	0.81	0.18	23.8
SC-4	568	0.63	0.17	55
SC-5	463	0.23	0.22	-
SC-6(Coconut carbon)	867	0.40	0.34	-

Five different synthetic porous carbons and one coconut carbon were used as adsorbents. They had clearly different specific surface areas and pore size distributions.

SEM observation



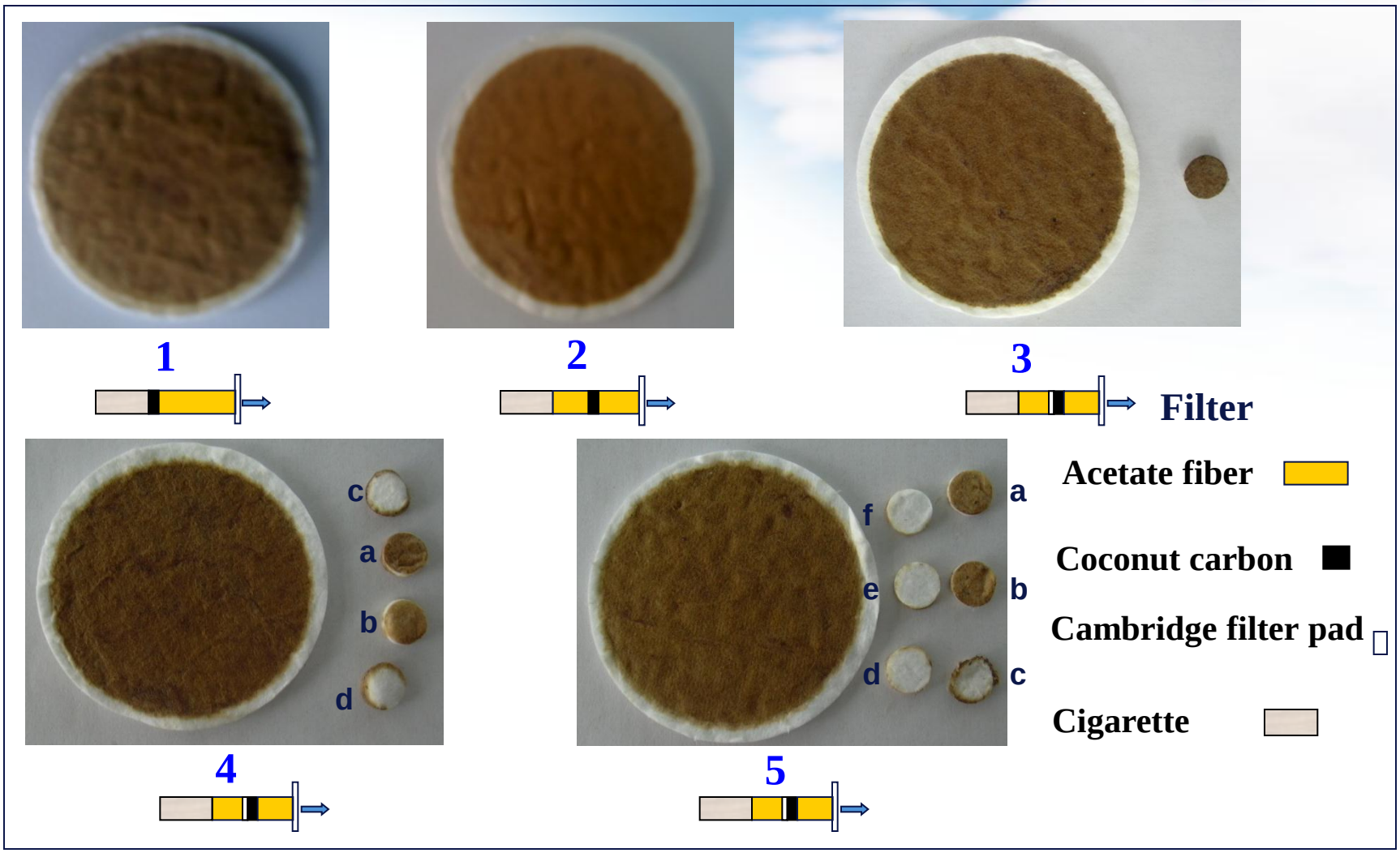
SC- 3



SC- 5

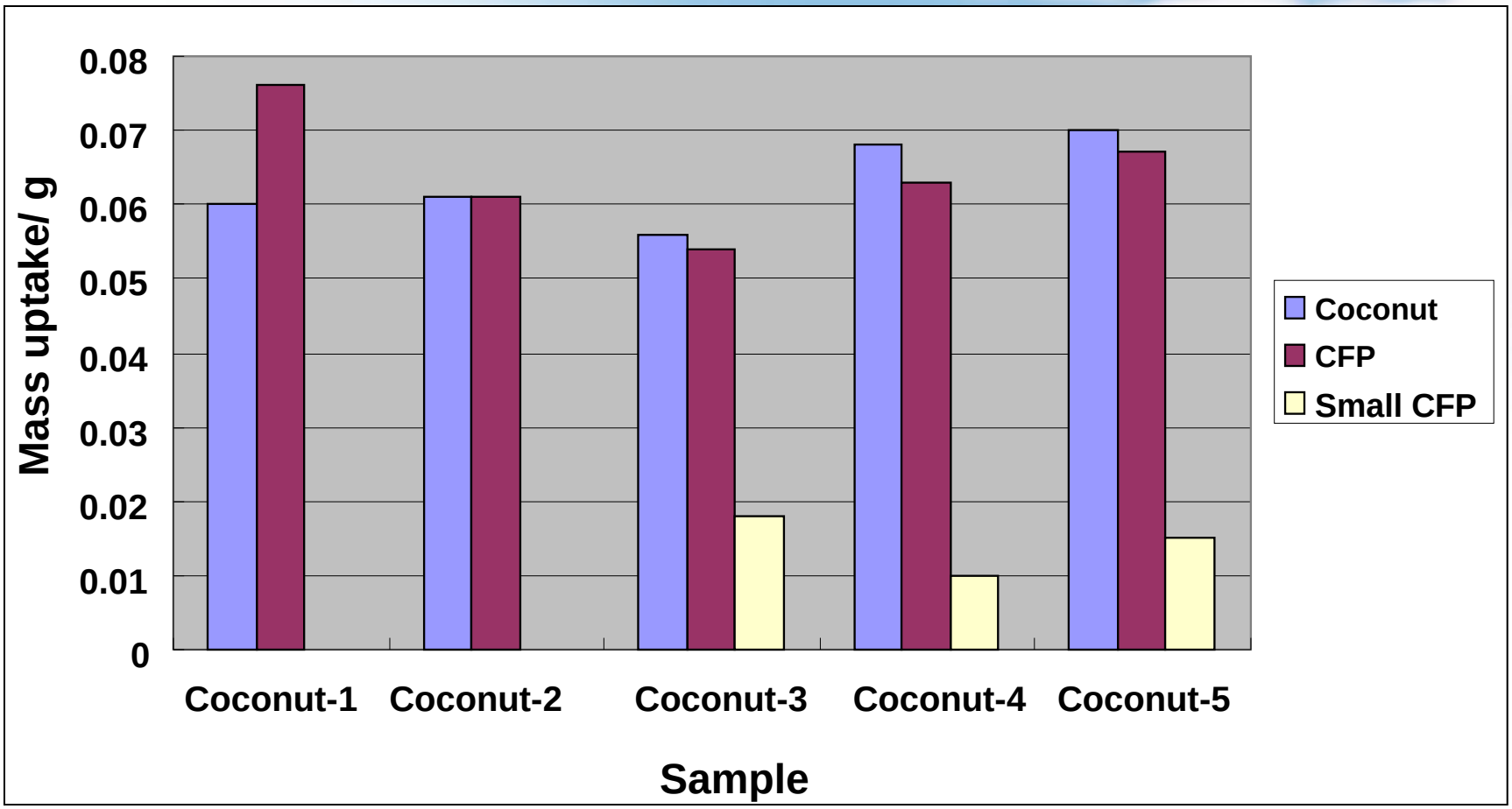
SEM images of porous carbons with different pore structure

Position of the carbons in the filter



Schematic illustrations for the position of the carbons in the filter

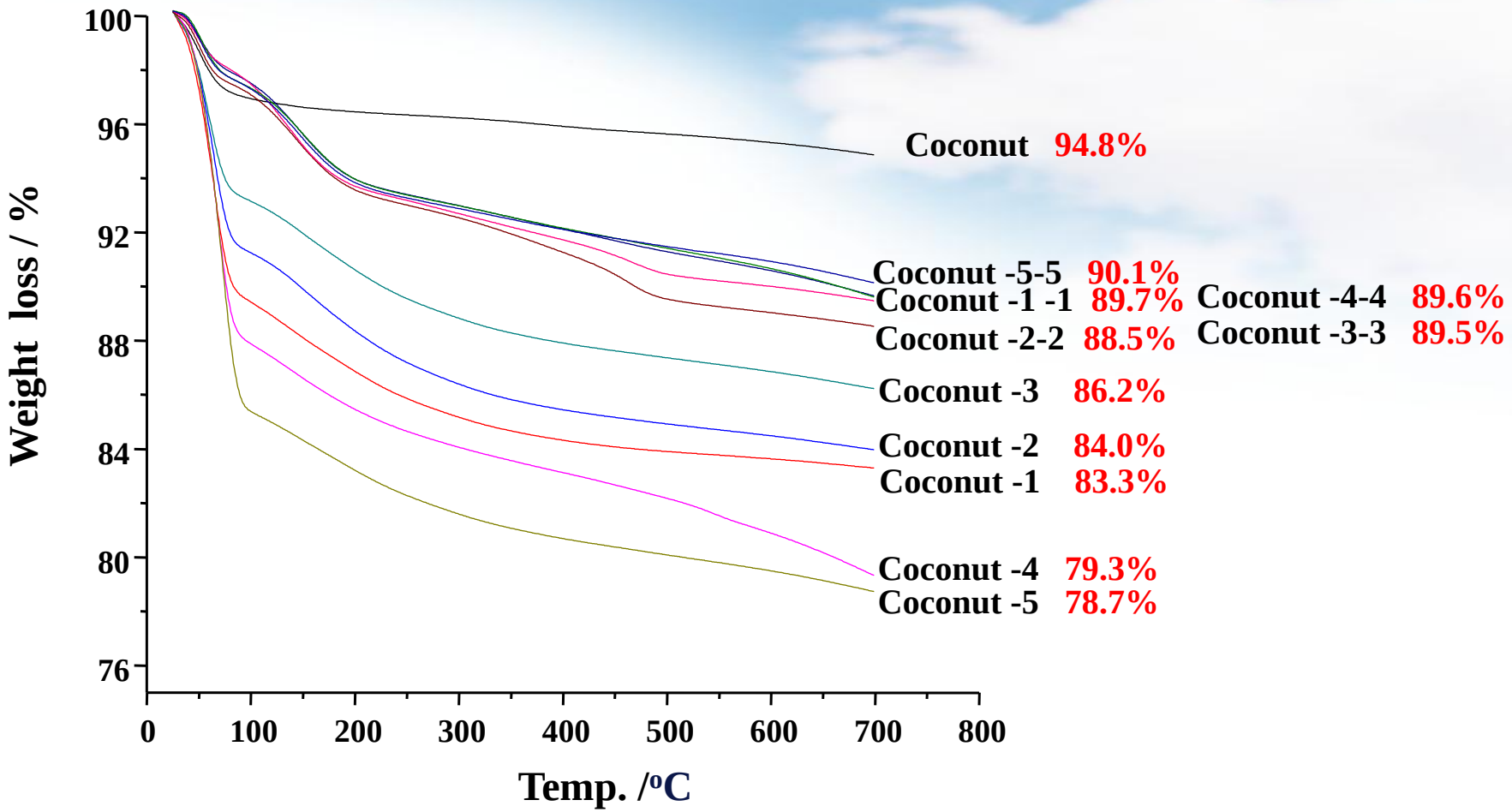
Mass uptakes of the carbons and pads



Mass uptakes for coconut carbons and Cambridge filter pads

Tar deposition on coconut carbon caused a negative impact on the carbon adsorption capacity.

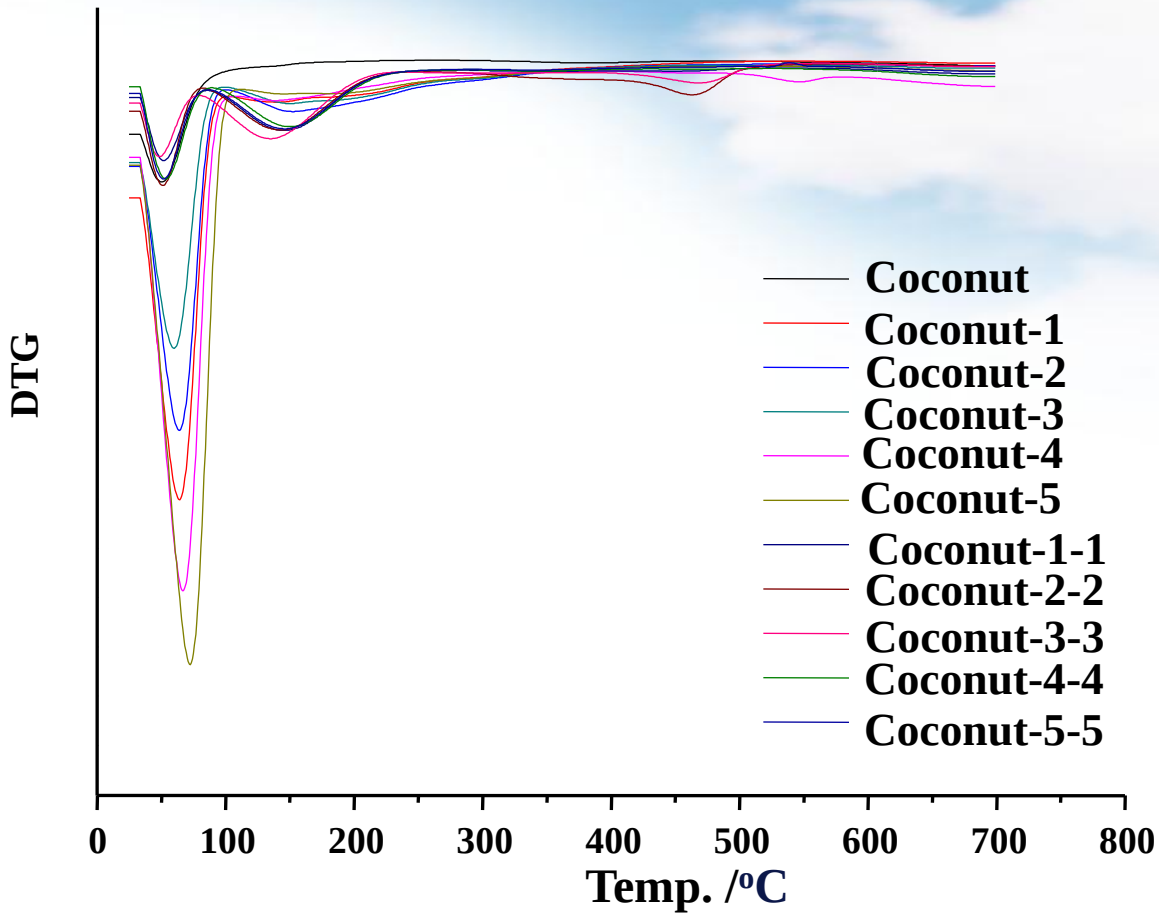
TG curves



TG curves of coconut after smoking

More pieces of small Cambridge filter pads placed in front of carbon resulted in a greater weight loss of the carbon, indicating a better adsorption performance of the carbon.

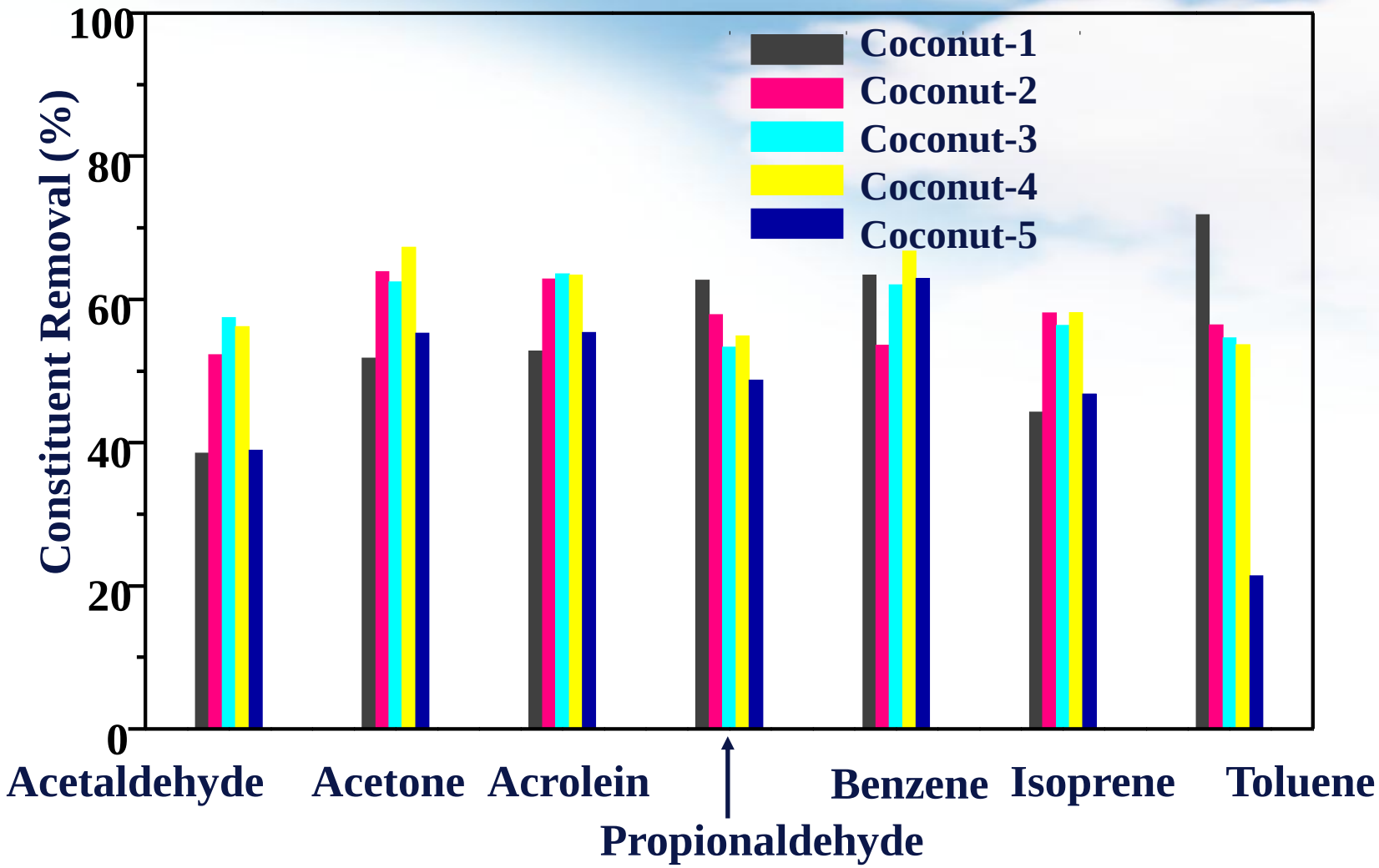
DTG curves



DTG curves of coconut after smoking

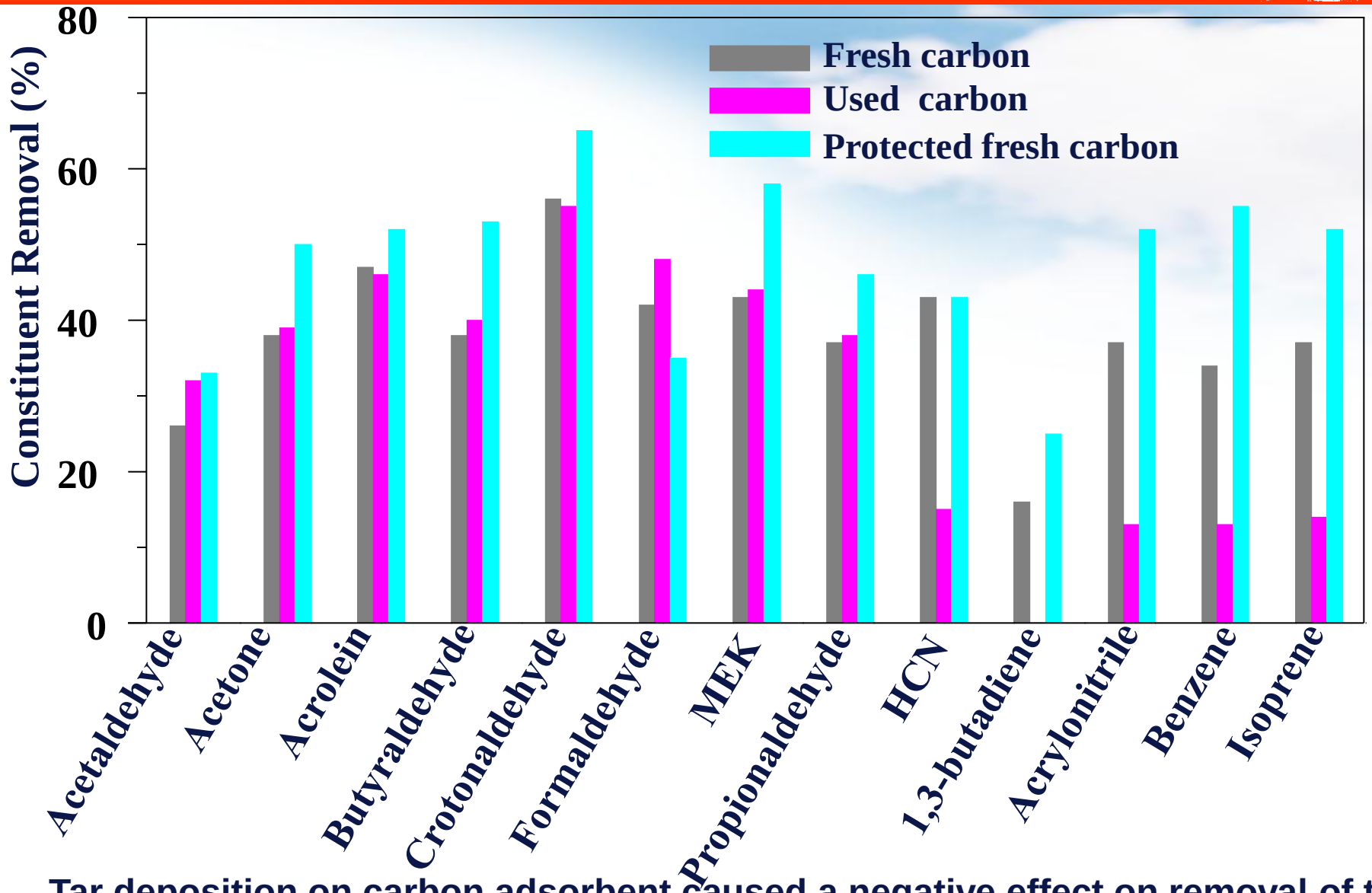
Samples showed a very fast mass loss at ca. 63 °C. Most of the adsorbed compounds volatilized from the coconut carbon around this temperature.

Removal efficiency



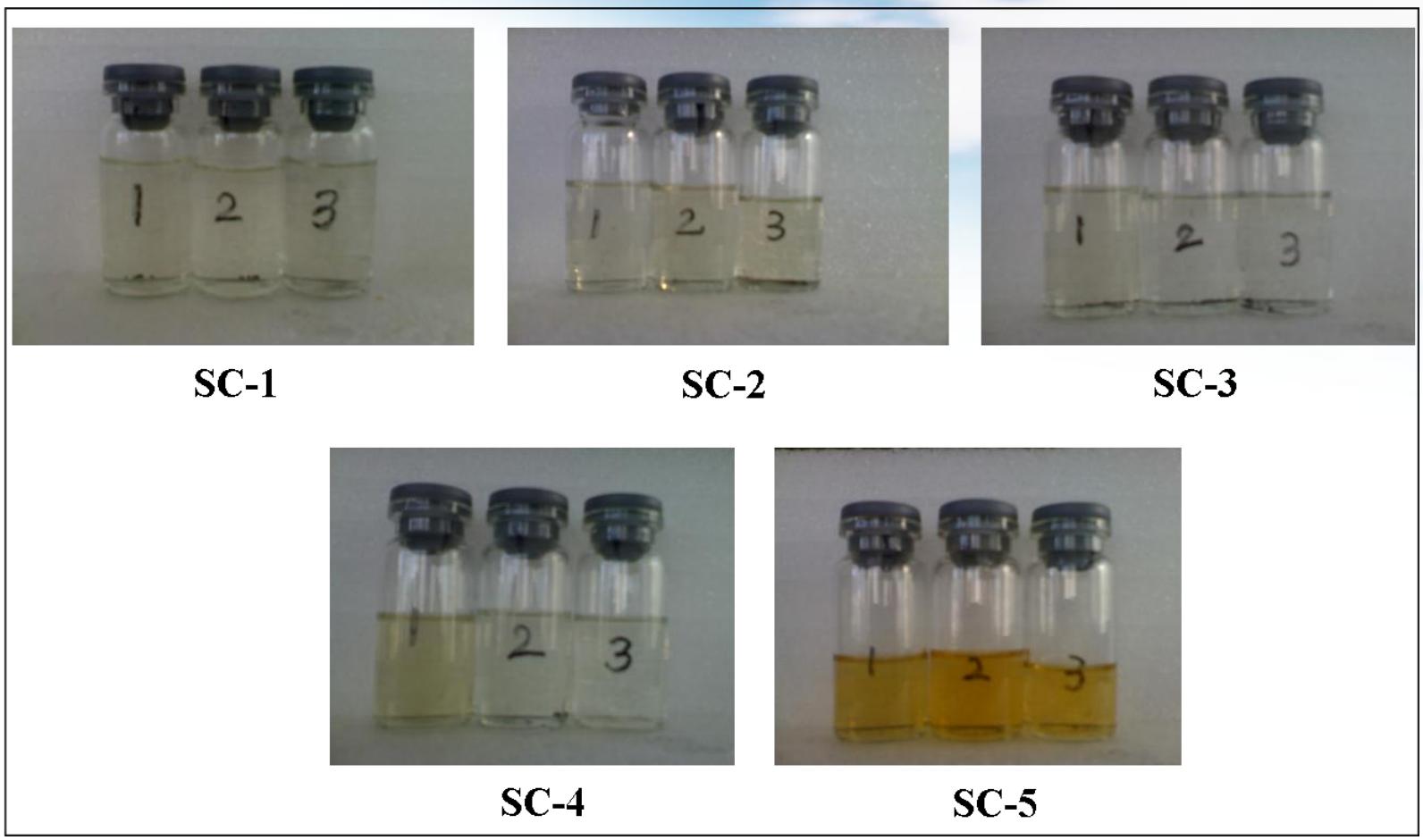
The tar deposition on the surface of coconut carbon prevented further absorption of toxicants in the smoke vapor phase.

Removal efficiency



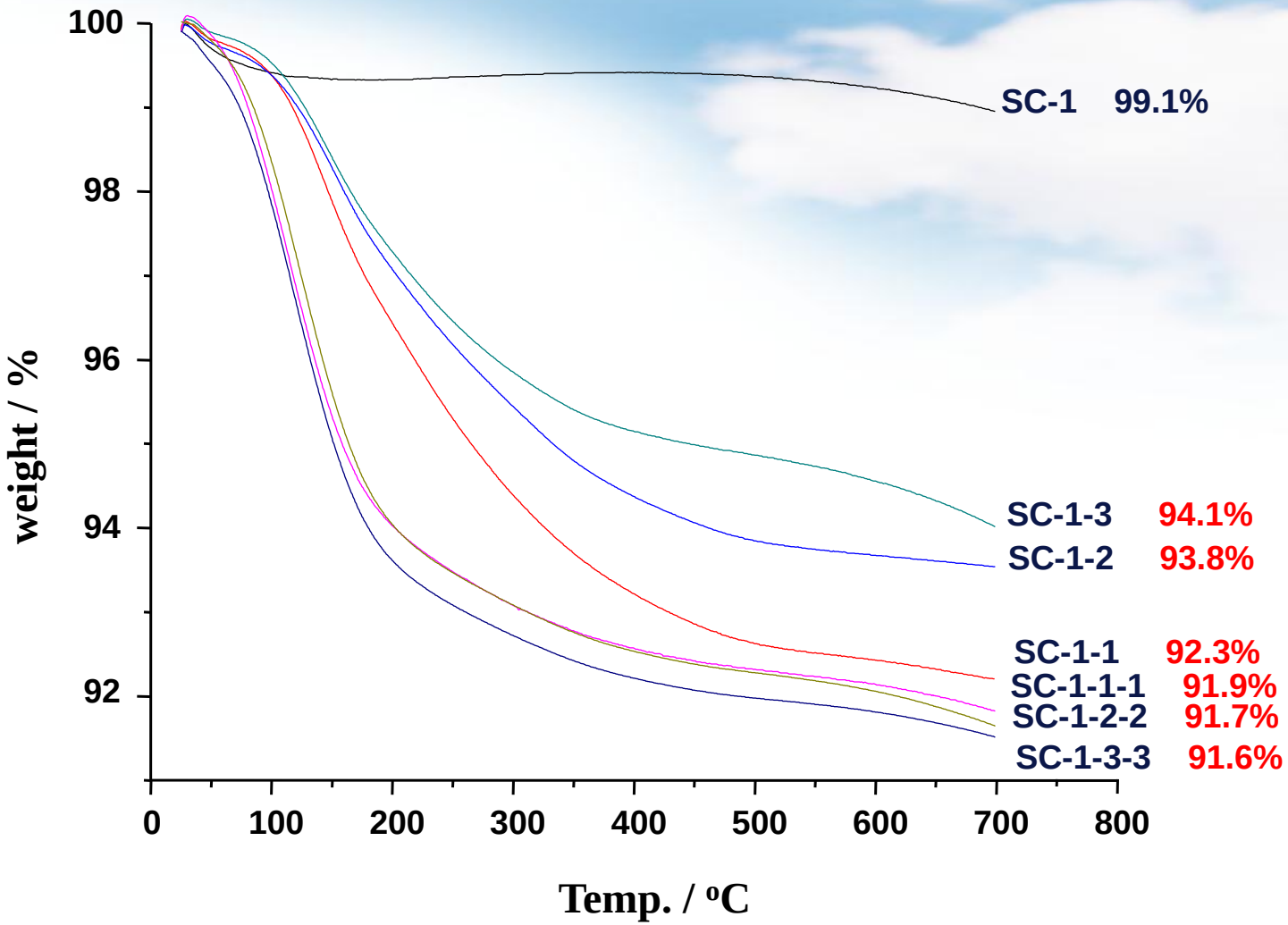
Tar deposition on carbon adsorbent caused a negative effect on removal of the majority toxicants in a vapor

Carbon extraction by acetone



Photos of the extracted acetone solutions of different carbons

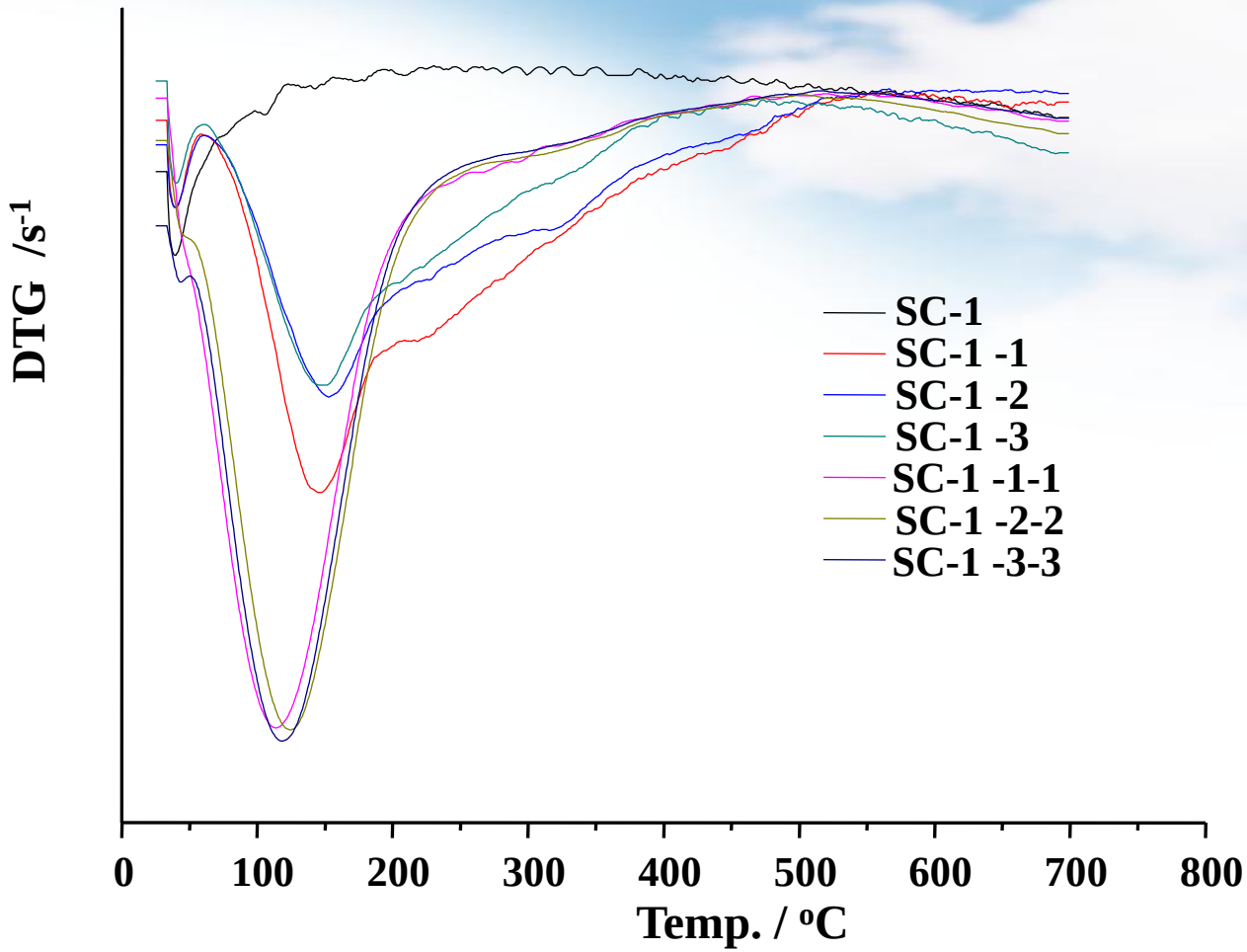
TG curves



TG curves of sample SC-1 series

The porous carbon with different position in the filter showed different weight loss, indicating different absorb amount of the tar and the toxicants.

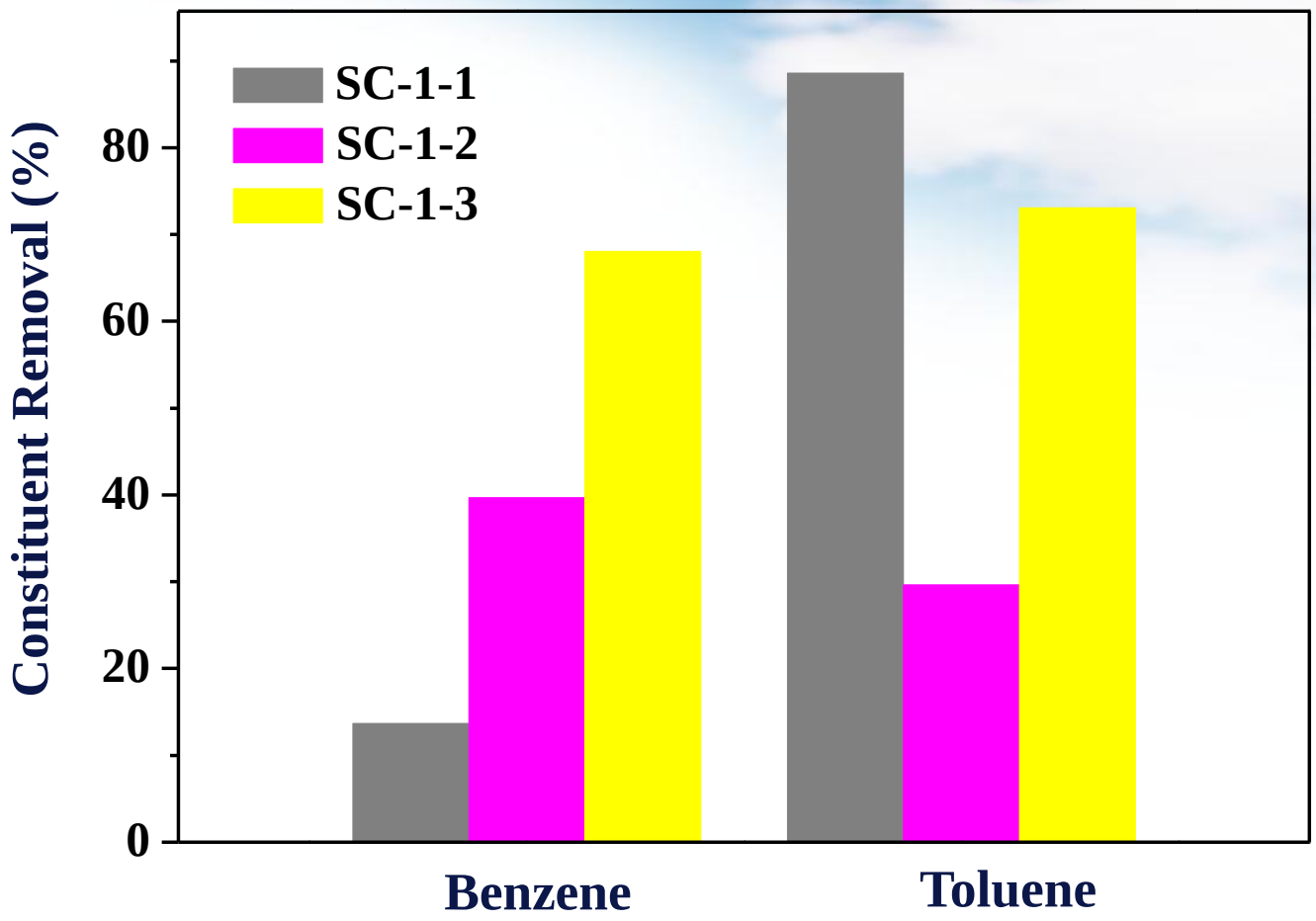
DTG curves



DTG curves of sample SC-1

A very fast mass loss was observed at ca. 110 °C. That meaned most of the adsorbed compounds volatilize from carbon SC-1.

Removal efficiency



Constituent removal of benzene and toluene using porous carbon SC-1

Aromatic compounds benzene and toluene were selected as probe molecules. Protected carbon showed better adsorption performance.

Conclusions

- The deposition of tar on the surface of coconut carbon was detrimental to the adsorption of selected toxicants in the smoke vapor phase

- Comprehensive analysis showed that when using porous carbon as the adsorbent of cigarette filter, appropriately protecting carbon from tar deposition could achieve the best results

Acknowledgement

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THE END!

Thank you for your attention!

CORESTA CONGRESS EDINBURGH 2010

Promoting the Scientific Basis for Tobacco Product Regulation

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