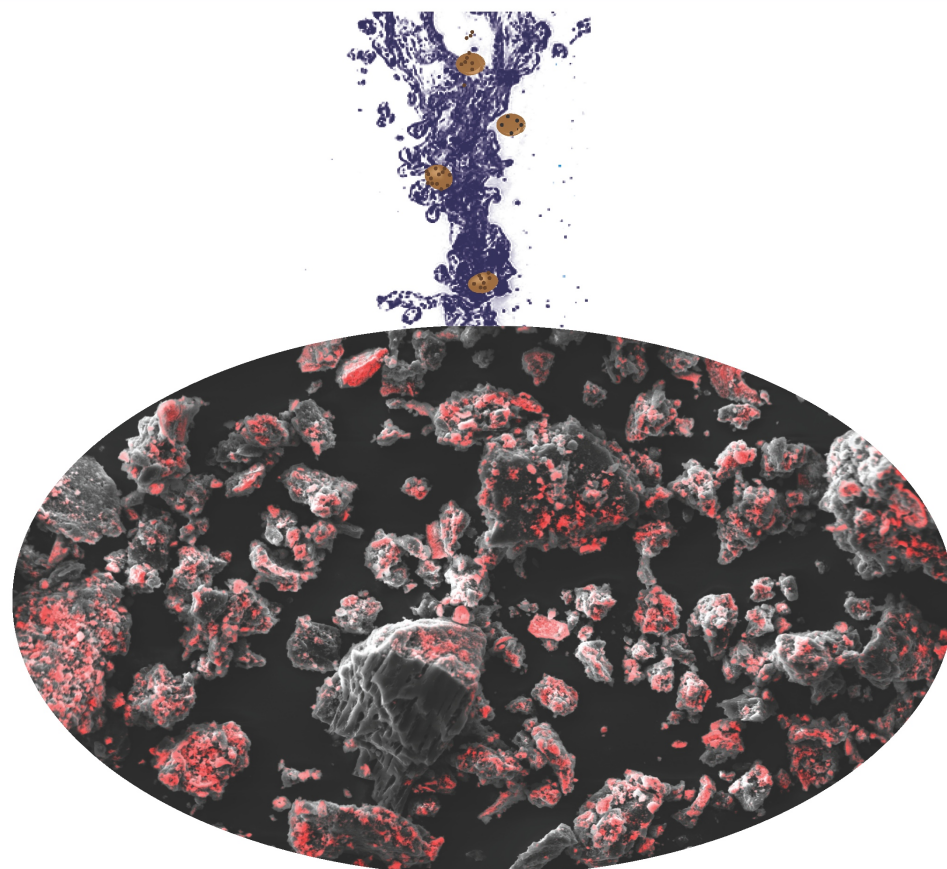


Sorbent materials have various environmental applications, i.e. water filtration, separation and purification. Rapid progress in nanotechnology and a new focus on biomass-based instead of non-renewable starting materials have produced a wide range of novel engineered sorbents.

The development and evaluation of novel sorbents requires a multidisciplinary approach encompassing environmental, nanotechnology, physical, analytical, and surface chemistry. The necessary evaluations require not only the efficiency of these materials to remove contaminants from surface waters and groundwater, industrial wastewater, polluted soils and sediments, etc., but also the potential side-effects of their environmental applications. Contributions examining the use of novel sorbents for environmental remediation are welcome. More specifically the contributions may be focused on:

- biosorbents: characterization; evaluation
- biochar: process optimization; physically and chemically activated biochar
- reactive sorbents: development; characterization; evaluation
- nanotechnology based sorbents: development; characterization; evaluation
- sorbent based in situ remediation of contaminated soils, aquifers and sediments: experimental work; field studies
- toxicity of novel sorbents






Abstract deadline: January 16, 2014 (November 29, 2013 for financial support)
<http://meetingorganizer.copernicus.org/EGU2014/session/14572>




Posters SSS9.8

Novel sorbent materials for environmental remediation

Convener: Ioannis D. Manariotis 

Co-Conveners: Hrisi K. Karapanagioti  and David Werner 

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Attendance Time: Friday, 02 May, 17:30–19:00

Blue Posters

Chairperson: Ioannis D. Manariotis

B148 [EGU2014-707](#)



Searching for recyclability of modified clays for an environmental application

Carmen Del Hoyo Martínez, Marina Solange Lozano García, Vicente Sánchez Escribano, and Jorge Antequera

B149 [EGU2014-6484](#)



Using sorbent waste materials to enhance treatment of micro-point source effluents by constructed wetlands

Verity Green, Ben Surridge, John Quinton, and Mike Matthews

B150 [EGU2014-1926](#)



Cetylpyridinium chloride/magnetic alginate beads: an efficient system to remove p-nitrophenol from wastewater

Layaly OBEID, Agnes BEE, Delphine Talbot, Sebastien Abramson, and Mathias Welschbillig

B151 [EGU2014-949](#)



Biochar from Coffee Residues: A New Promising Sorbent

Kalliopi Fotopoulou, Hrisi Karapanagioti, and Ioannis Manariotis

B152 [EGU2014-5335](#)



Evaluation of the sediment remediation potential of magnetite impregnated activated carbons and biochars

David Werner, Zhantao Han, and Hrisi Karapanagioti

B153 [EGU2014-16564](#)



Organic hydrogels as potential sorbent materials for water purification

George Linardatos, Vlasoula Bekiar, and George Bokias

B154 [EGU2014-15789](#)



Hydrothermally prepared biochars from potato peels. Activation of biochars with phosphoric acid for use as sorbents for cobalt removal from wastewaters

Evangelos Lakkovikiotis, George Kyzas, Eleni Deliyanni, and Kostas Matis

B155 [EGU2014-11279](#)



The use of exopolysaccharide - producing cyanobacteria as biosorbents to remove copper from industrial waste - waters

Federico Rossi, Hajar El Badaoui, and Roberto De Philippis

B157 [EGU2014-8923](#)



Synthesis of magnetic adsorbents for the removal of Hg(II) from aqueous solutions

Ekavi C. Isari, Hrisi K. Karapanagioti, Ioannis D. Manariotis, and David Werner

B158 [EGU2014-1472](#)



Hybrid biosorbents for removal of pollutants and remediation

Juris Burlakovs, Maris Klavins, Artis Robalds, and Linda Ansone

B159 [EGU2014-1742](#)



Grafted cellulose for PAHs removal present in industrial discharge waters

Elise Euvrard, Coline Druart, Amandine Poupeney, Nadia Crini, Elena Vismara, Tommaso Lanza, Giangiacomo Torri, Sophie Gavaille, and Gregorio Crini

B160 [EGU2014-4385](#)



Freshwater and marine microalgae harvesting with magnetic microparticles

Sofia Vergini, Andriana Aravantinou, and Ioannis D. Manariotis

B161 [EGU2014-4518](#)



Raw and Treated Rice Husks as Sorbents for Mercury Removal from Aqueous Solutions

Maria R. Befani, Ioannis D. Manariotis, Hrisi K. Karapanagioti, and César E. Quintero

B162 [EGU2014-5665](#)



Synthesis of amino functionalized hollow core-mesoporous shell silica spheres for heavy metals adsorption and recovery

Mohamed Habila, Ahmed El-Toni, Mohamed Ibrahim, Joselito Labis, and Zeid ALOthman

B163 [EGU2014-6508](#)



Evaluation of malt spent rootlets biochar as catalyst for biodiesel production.

Dimitra Pantiora



Hydrothermally prepared biochars from potato peels. Activation of biochars with phosphoric acid for use as sorbents for cobalt removal from wastewaters

Evangelos Lakkovikiotis, George Kyzas, Eleni Deliyanni, and Kostas Matis

Laboratory of General and Inorganic Chemical Technology, Aristotle University of Thessaloniki, Greece

In the present study, activated carbons (ACs) were hydrothermally prepared with an environmental friendly preparation route from biomass (specifically from potato peels). The prepared biochars were activated with phosphoric acid (chemical activation). The porous texture and the surface chemistry of the biochars and the relative activated carbons prepared were investigated and were compared to the activated carbon prepared and activated by pyrolysis, in one step procedure. Biochars and activated carbon materials were also characterized by Scanning Electron Microscopy (SEM) and Fourier Transform Infrared (FTIR) spectroscopy. The prepared activated carbons were used as adsorbents for the removal of cobalt from aqueous solutions. Batch experiments were performed to investigate the effect of physico-chemical parameters, such as pH, adsorbent dose, contact time, initial metal concentration and temperature. The kinetics of adsorption were studied by applying the pseudo-first order, pseudo-second order and intraparticle diffusion models. Equilibrium data were analyzed using Langmuir and Freundlich isotherm models. The thermodynamic parameters such as the change of enthalpy (ΔH^0), entropy (ΔS^0) and Gibbs free energy (ΔG^0) of adsorption systems were also determined and evaluated.



Hydrothermally prepared biochars from potato peels. Activation of biochars with phosphoric acid for use as sorbents for cobalt removal from wastewaters



Evangelos Th. Lakkovikiotis, George Z. Kyzas, Eleni A. Deliyanni, Kostas A. Matis

Laboratory of General & Inorganic Chemical Technology, Department of Chemistry, Aristotle University of Thessaloniki, Greece

Aim of the study

Activated carbons (ACs) were hydrothermally prepared with an environmental friendly preparation route from biomass (specifically from potato peels). The prepared biochars were activated with phosphoric acid (chemical activation). The porous texture and the surface chemistry of the biochars and the relative activated carbons prepared were investigated and were compared to the activated carbon prepared and activated by pyrolysis, in one step procedure. Biochars and activated carbon materials were also characterized by Scanning Electron Microscopy (SEM) and Fourier Transform Infrared (FTIR) spectroscopy. The prepared activated carbons were used as adsorbents for the removal of cobalt from aqueous solutions. Batch experiments were performed to investigate the effect of physico-chemical parameters, such as pH, contact time, and initial metal concentration.

Synthesis with hydrothermal route

Potato peels were obtained either from Greek cultivars or as residues from restaurants. Prior to the use, the potato peels were repeatedly washed with distilled water in order to remove dust and other inorganic impurities, then oven-dried for 24 h at 393 K to reduce the moisture content. The dry material was ground and then sieved to obtain uniform particle size of 0.45-0.15 mm. It is denoted as PP.

For the hydrothermally prepared activated carbon, an amount of the raw potato peels precursor (20 g) was dispersed in 100 mL of water. The hydrocarbonization process (HTC) of the precursors was carried out in a 0.5-L Parr stirred pressure reactor (Parr Instrument Company, Moline, Illinois, USA). The mixture was sealed into a Teflon vessel and then inserted in the autoclave, which was subjected to 200 °C at a heating rate of around 4 °C min/L. It was maintained at this temperature for 24 h with agitation speed of 150 rpm and after then the autoclave was cooled down to room temperature. The reaction mixture, consisting of a liquid solution and solid phase (hydrochar) was collected in a glass beaker for separation by filtration and the solid was washed thoroughly with hot distilled water and then with ethanol and dried in an oven at 100 °C overnight. The solid yield was determined by weight.

Chemical activation of the biochar was performed using a 2 M solution of H_3PO_4 . The appropriate volume of H_3PO_4 were dissolved in 250 mL of distilled water and then 20 g of the pp were mixed with the H_3PO_4 solution and stirred overnight in order a complete reaction between PP and H_3PO_4 to be achieved. The mixture was filtered and the remaining solid was dried at 100 °C for about 24 hours. It was placed then in a furnace and heated to 600 °C at a heating rate of 25 °C/min under nitrogen flow of 500 mL/min for 2 h. The final activated carbon formed was designated as PP-HYD. The prepared carbon was washed, dried, ground and sieved.

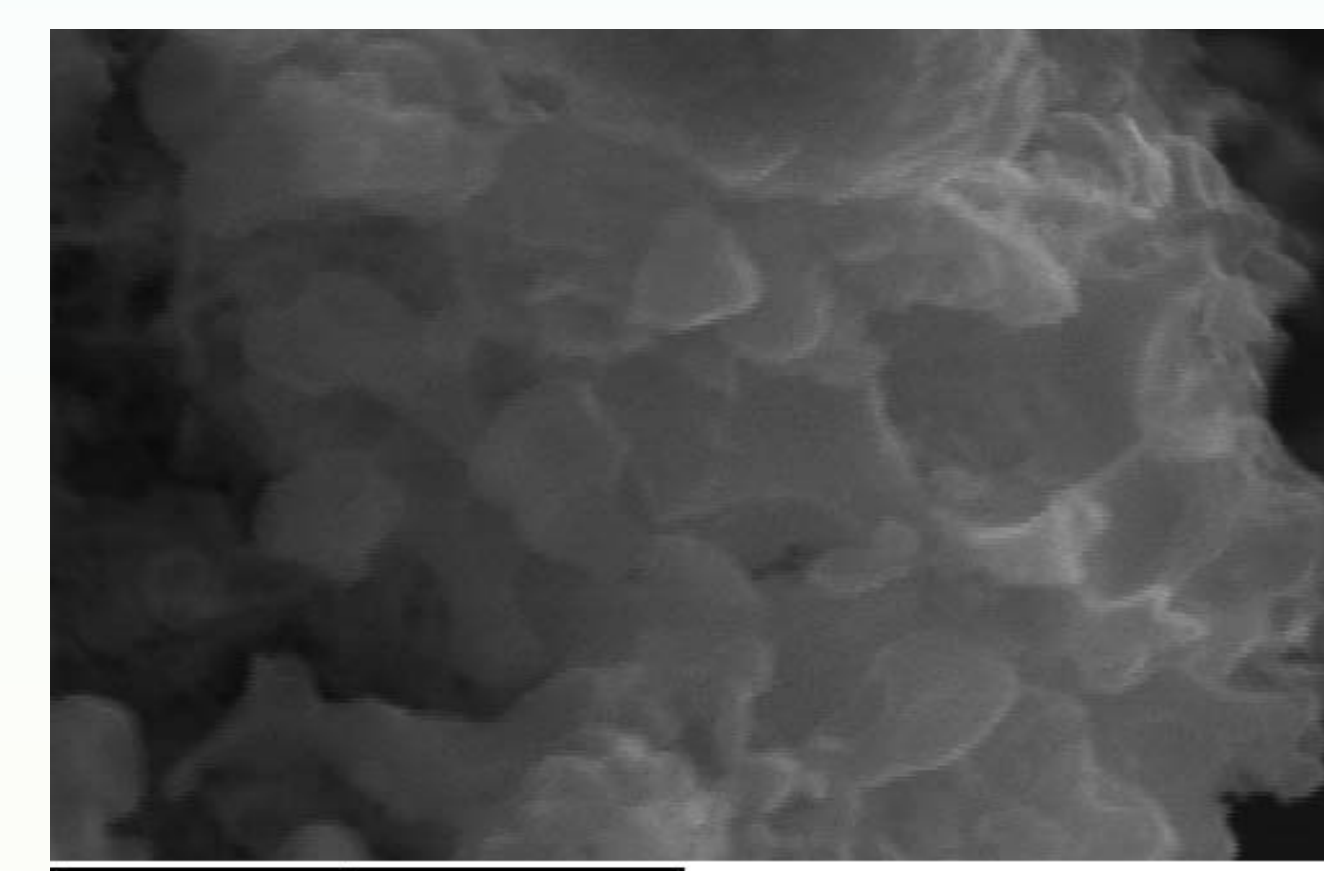
Synthesis with pyrolysis route

For the carbon produced by the raw potato peels precursor (PP) with H_3PO_4 activation, the dry potato peels precursor (20 g) was impregnated with 250 mL of the activation agent (2M H_3PO_4) at room temperature for 24 h. The mixing was filtrated and placed in a furnace. All treatments were done at a constant heating rate of 10 K/min and with nitrogen (99% pure) flow of 30 STP cm^3/min , which was kept during heating and cooling (while the activation temperature was 600 °C for 2 h). After cooling, the solid pyrolysis residue to room temperature was washed with milli-Q distilled water until constant pH (measured with a pH meter HP, model CRISON 602). The resulting activated carbon was dried at 100 °C for 24 h in a vacuum furnace. The activated carbon was labeled as PP-PYR.

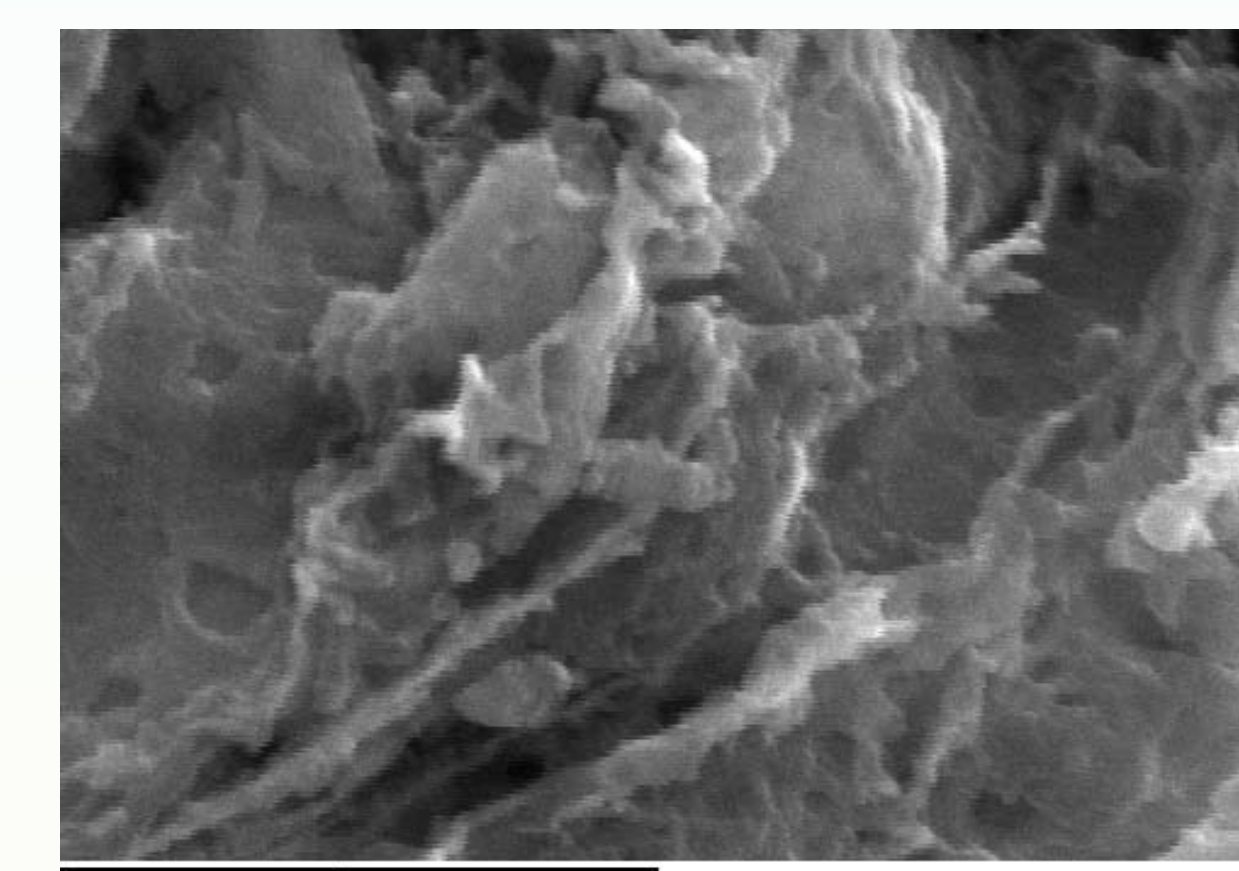
Adsorption procedure

Batch experiments were carried out using 1 g/L of adsorbent each time ($m = 0.02$ g of adsorbents' mass were added to $V = 20$ mL of deionized water in a conical flask). Samples were taken at predetermined time intervals. For the pH-effect experiments ($C_0 = 50$ mg/L), the solution pH was initially adjusted with aqueous solutions of acid or base (0.01 mol/L of HCl and/or 0.01 mol/L NaOH) to reach pH values of 2-12. The agitation rate was fixed at 160 rpm for all adsorption tests. Isotherms were taken running the adsorption experiments with various initial cobalt concentrations ($C_0 = 0$ -200 mg/L) at 25 °C for 24 h (contact time). Kinetic tests were performed using $C_0 = 50$ mg/L at 25 °C (at pH = 5 given that it was found to be the optimum value according to pH-effect tests) for different contact-time intervals during adsorption ($t = 0$ -24 h).

SEM characterization



PP-PYR

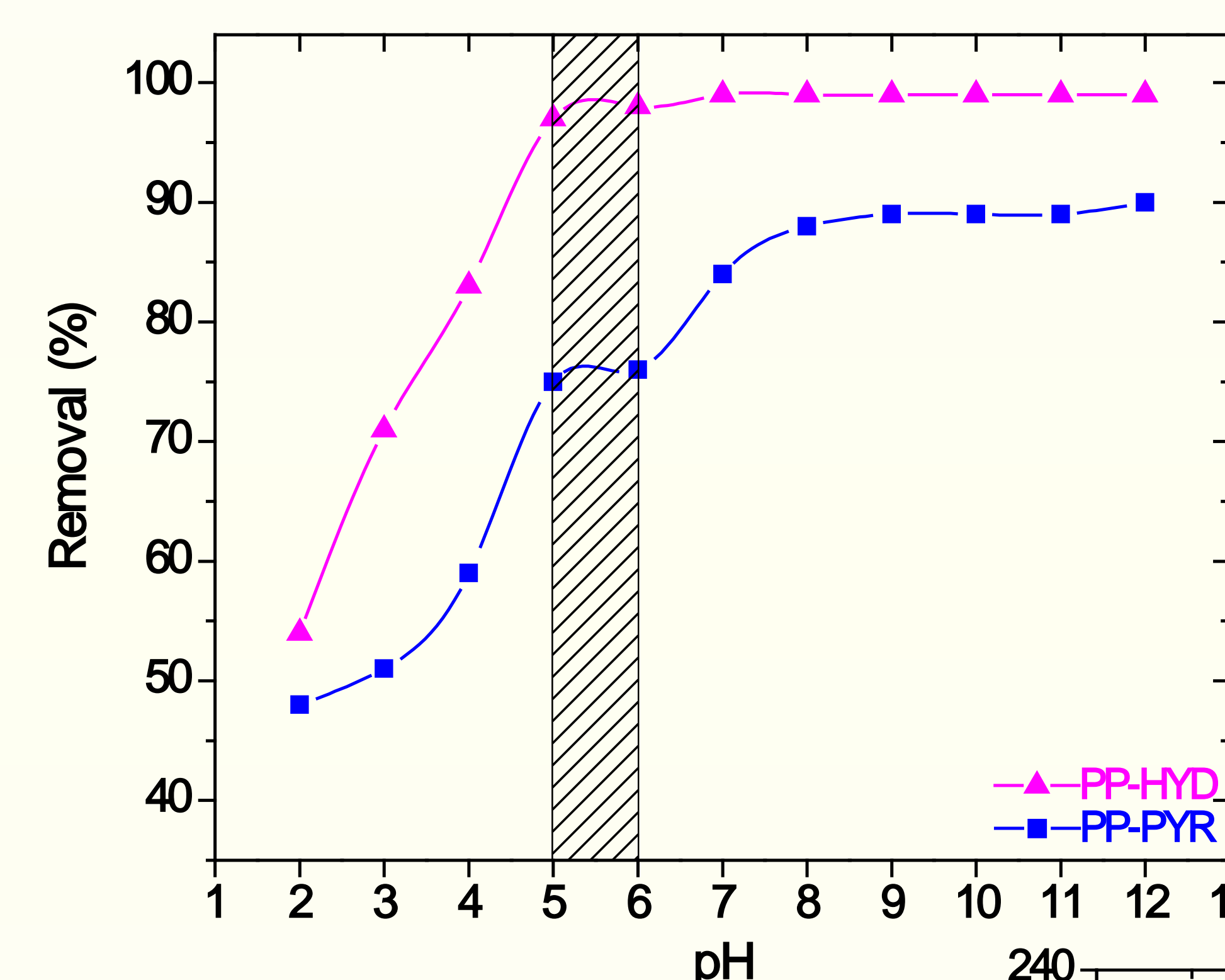


PP-HYD

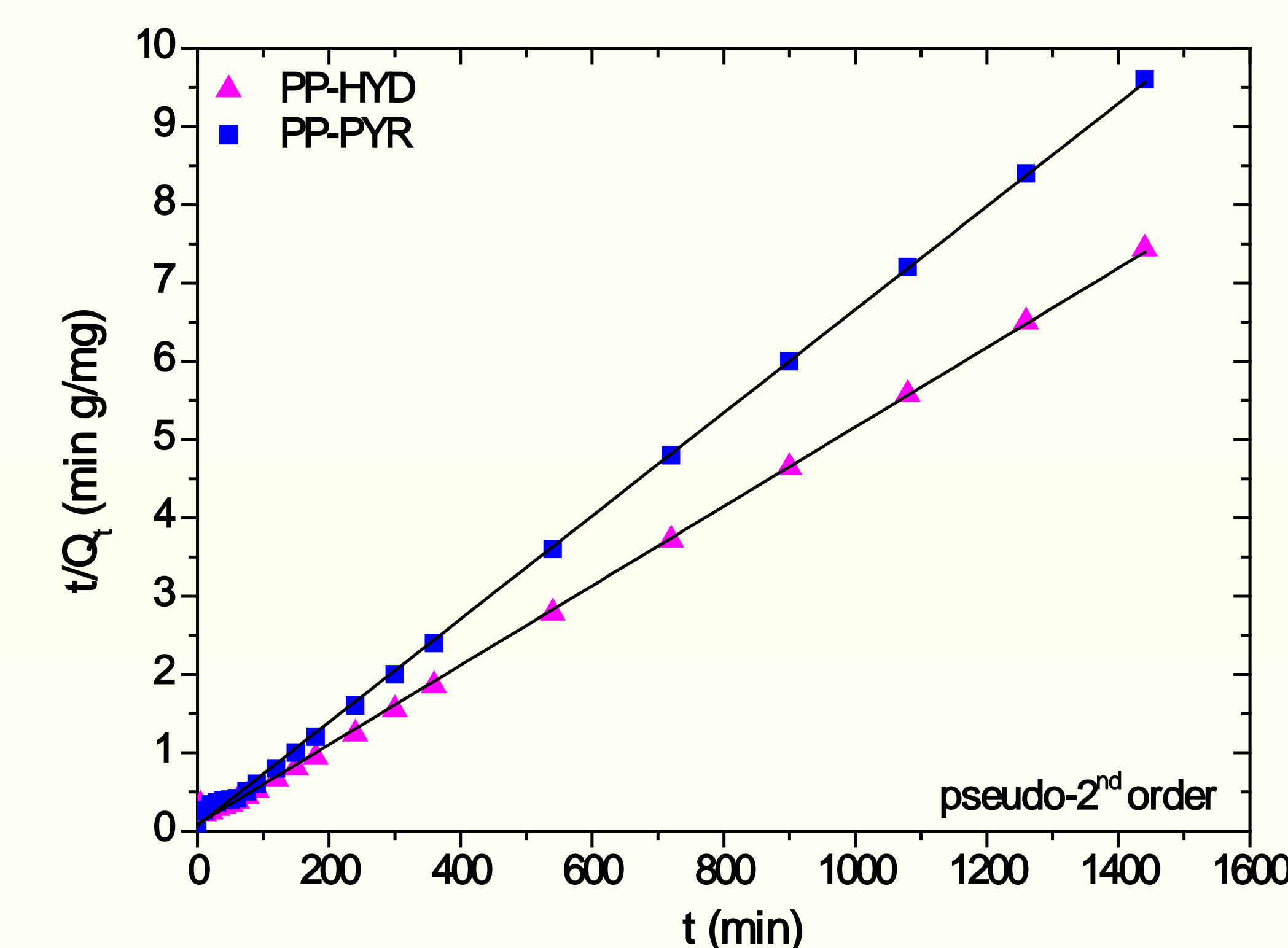
SEM micrographs

The SEM images of the prepared carbons showed a different morphology. The pyrolyzed sample (PP-PYR) has milder surface with some straps. After hydrothermal treatment, the carbon obtains sharp edges and channels which can be attributed to the conditions of this synthesis route

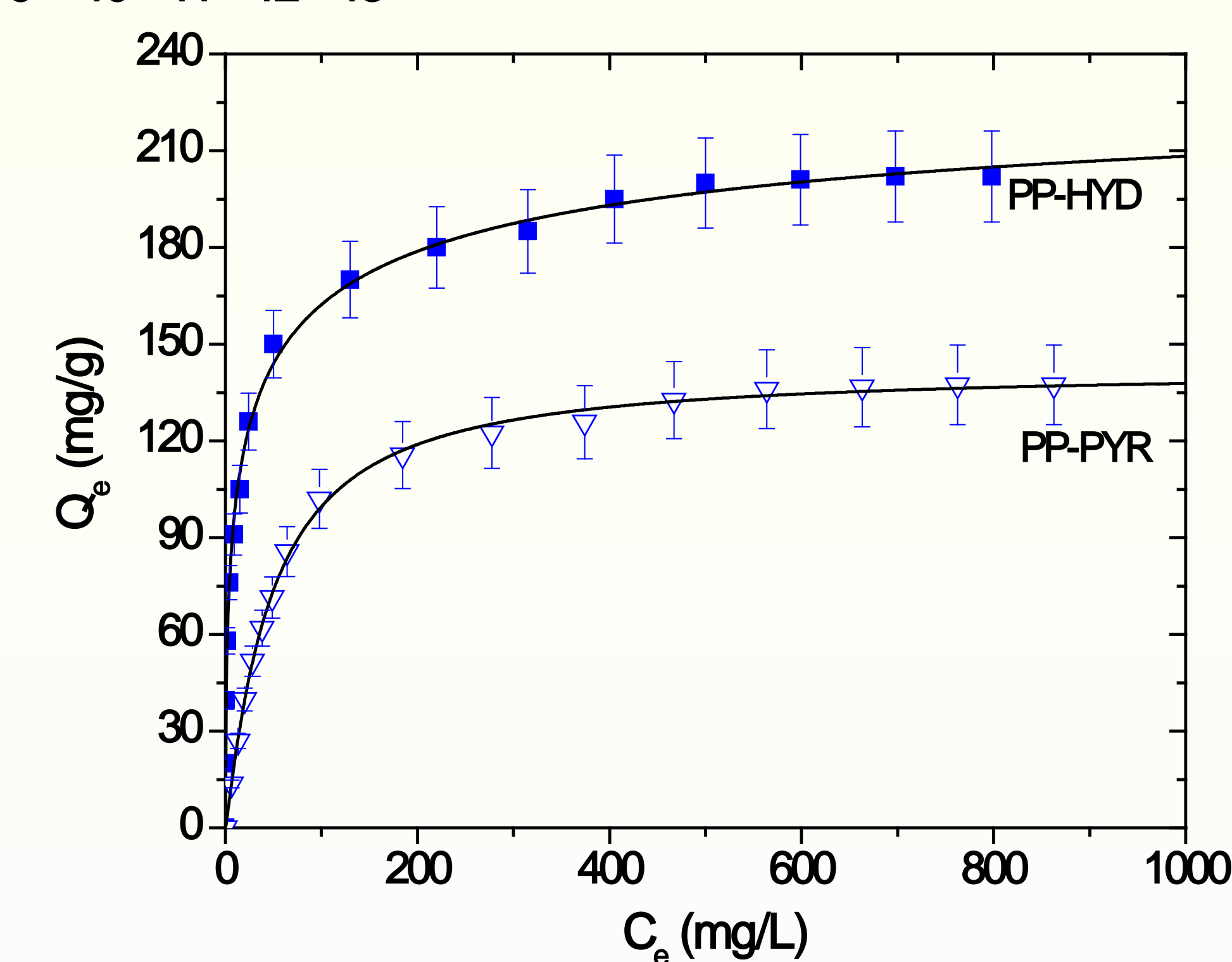
Adsorption evaluation



Effect of pH



Effect of contact time



Effect of initial cobalt concentration

Conclusions

- ✓The pH selected as optimum for further adsorption experiments was pH=5, where the adsorbents presented the maximum removal just before the pH-zone of 6-12 where precipitation phenomena dominate.
- ✓Equilibrium data were fitted to the Langmuir, Freundlich and Langmuir-Freundlich (L-F) model. The best correlation was for L-F model ($R^2 \sim 0.998$).
- ✓Kinetic data were fitted to the pseudo-first, -second and -third order model. The best correlation was for pseudo-second order equation ($R^2 \sim 0.996$).
- ✓PP-HYD presented better adsorption behavior (higher adsorption capacity~210 mg/g) than PP-PYR (~130 mg/g).