NANOSTRUCTURAL SPHERICAL CARBON PARTICLES FROM ACRYLIC WASTE

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Abstract

Acrylic fibres can be used as a source of carbon structures. The reason is in chemical structure and thermal behaviour of acrylic polymer which is not melt-able and contains high quantity of carbon. Acrylic fibres are one of typical wastes from textile industry.

Until recently these fibres are burnt or dumped as garbage. In this study an easy method is presented to prepare nanostructural spherical carbon particles with diameter around one micrometre. Particles are prepared at 500°C in oven with protection against oxidation. These particles are evaluated by standard methods.

Keywords: Acrylic, fibres, waste, carbon, recycling

1. INTRODUCTION

Carbon particles with high surface area are commercially useful in many sorption and separation processes. Carbon particles are suitable for application is storage of gases or photonics. Many researchers are working on preparation of spherical carbon particles, which are interesting for hi- tech applications. [1]

Active carbon is typically prepared from natural products such as wood. A wide variety of carbons has been prepared from biomass and other wastes, such as date pits [2], olive stones [3], furniture, sewage char and tyres [4,5].

Textile wastes are now a serious problem. Production of fibres is growing worldwide and recycling is not used in enough high scale. Approximately 80% of synthetic fibres are made from polyesters or polyamides. Acrylics fibres presently occupy approximately 10% of all synthetic fibres.

This study is focused on not so common acrylic fibres, which contain high quantity of -CN groups with potential ecological and toxicological problems. Aim of this study is development of cheap and easy method to carbonize acrylic fibres.

The current research group has experience with textile chemistry and especially with high temperature processes by lasers [6], textile dyestuffs [7] and sorption properties. So the previous experience was used for high temperature carbonization of acrylic fibres and evaluation of properties for prepared carbon by sorption of selected dyestuff.

2. MAIN TEXT

2.1. Experiments - carbonization process

Experiments were realised with 100% acrylic fabric (plain wave, 195 g/m^2), structure of this fabric is visualised by scanning electron microscopy shown in **Figure 1**.

The laboratory oven produced by „Vaclav Svoboda EPS, Czech Republic“, was used for this study. Fibres were heated in the oven at temperatures 450°C, 500°C, 550°C and 600°C respectively for 60 minutes. Fibres were protected against oxidation by liquid salt system. The prepared carbon particles were cooled and tested.

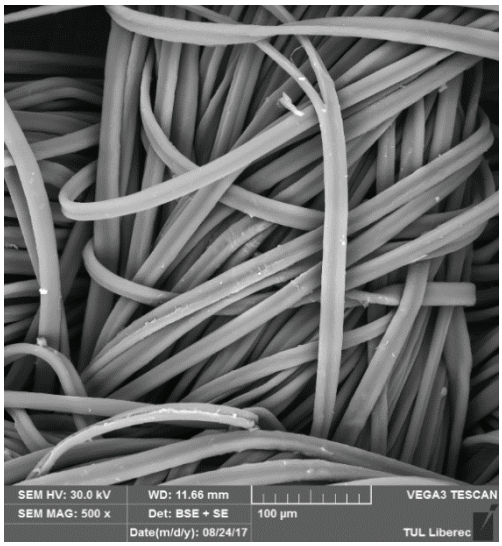

Figure 1 Structure of used acrylic fabric, SEM picture

2.2. Experiments - evaluation of sorption properties

Sorption properties of prepared carbon particles were evaluated by methylene blue test [8-13], which is optimised for our conditions. Methylene blue is a cationic dye with well-known structure (**Figure 2**, molecular mass 310 g/mol).

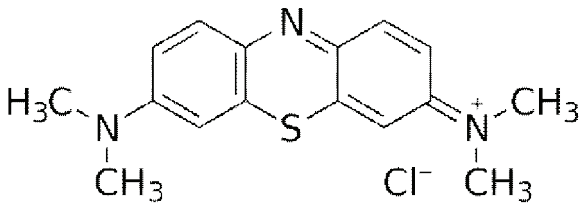

Figure 2 Chemical structure of methylene blue

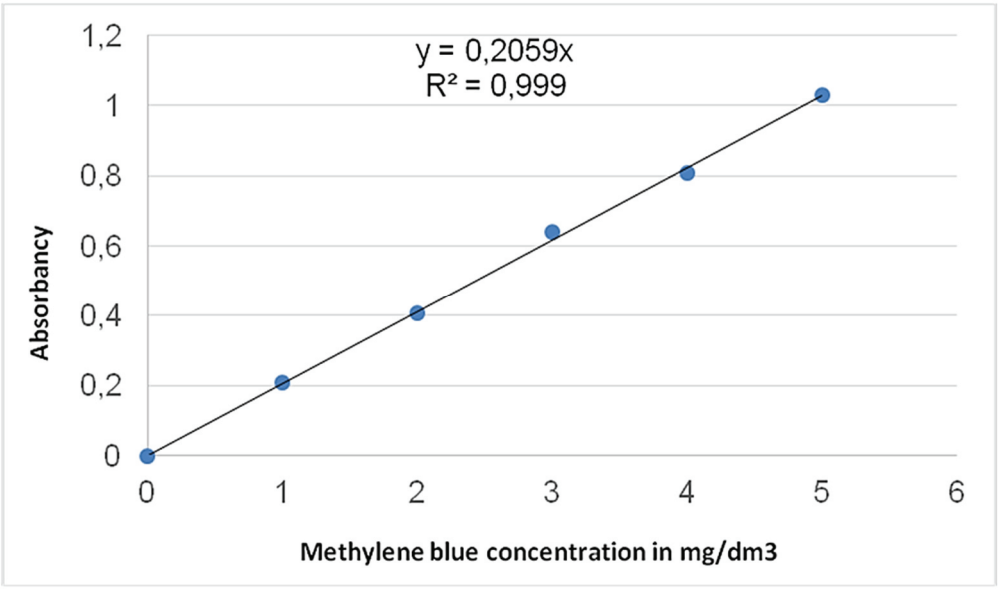

Figure 3 Calibration of spectrophotometry - dependence of absorbency on methylene blue concentration

Approximately 20 mg of prepared carbon particles was weighed on analytical scales. These carbon particles we suspended in 50 ml of methylene blue solution with concentration 70 mg/l. The experiments were carried out at 20°C, pH was set to 9 (pH meter CyberScan pH 510). After 60 minutes of stirring on a magnetic stirrer, the sorption by centrifugation of carbon particles from the system was done. Centrifuge Hettich EBA 20 was used with rotational speed 6000 per minute for about 2 minutes. Methylene blue concentration in used solution was analysed by direct measurement of absorbance on spectrophotometer at the 665 nm (Spectrophotometer UV-1600PC). Real concentration of methylene blue in used solution was calculated according to calibration curve as shown in **Figure 3**. These values were finally used for estimation of methylene blue mass absorbed by carbon particles.

2.3. Results and discussions

Shape and geometrical structure of carbon particles prepared from acrylic fibres were evaluated by scanning electron microscopy. The time - temperature regime of carbonization process was optimized to eliminate carbon particles with noncircular shape (**Figure 4**) and to prepare spherical particles only (**Figure 5**).

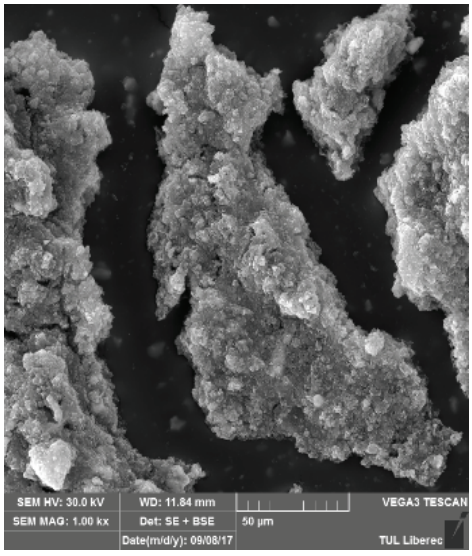

Figure 4 "Wrong" form of prepared carbon: nonspherical particles from SEM image

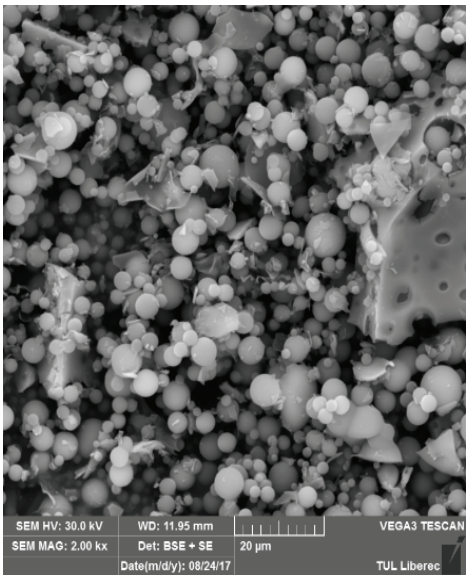

Figure 5 "Right" form of prepared carbon: spherical particles prepared at 500°C from SEM image

Prepared spherical particles absorbed high quantity of methylene blue. Best results were obtained at carbonization temperature of 550°C. Samples carbonized at 550°C absorbed 72 mg of methylene blue per one gram of carbon particles. Comparison with sorption properties of other prepared samples is shown in **Figure 6**.

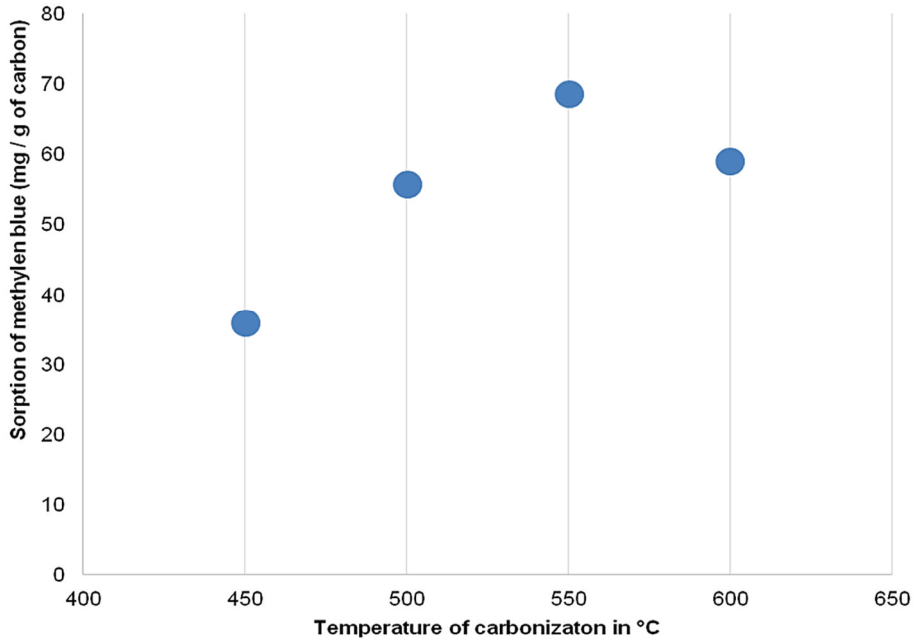

Figure 6 Sorption properties of prepared spherical carbon particles: influence of carbonization temperature

3. CONCLUSION

In this study, waste acrylic fibres were carbonized in melted salt system. At selected time - thermal regime, spherical particles with average diameter approximately 2 μm were obtained. Best results were observed at carbonization temperatures between 500 and 550 °C.

Sorption properties of prepared particles were tested by a modified sorption method. Carbon samples prepared at 550°C adsorbed approximately 72 mg of methylene blue per 1 g of prepared carbon particles. This value is comparable with other published results which reported carbon particles prepared by different methods.

ACKNOWLEDGEMENTS

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