

### **Pitches-based carbon/carbon composites**

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#### **Abstract**

The aim of this work is to present preliminary results on composites based on graphite fibers and carbon matrix derived from mesophase pitch. The samples were prepared by impregnating high modulus graphite fibers rovings with a liquid pitch to obtain the prepregs. The prepregs were subject to oxidative stabilization in air before pressing and carbonization of the samples. The FTIR, TGA, XRD analysis and mechanical testing have been used to characterize the pitches and composite samples in various stages of their preparation. Mechanical properties of various types of composite materials differing in the method of preparation were studied. Comparative analysis of the final properties of composite samples was made.

**KEYWORDS:** Carbon/carbon composites; Coal tar pitches; Thermogravimetry analysis; Infrared spectroscopy; X-ray diffraction

### **MECHANICAL PROPERTIES OF CARBON FIBRES - BASED COMPOSITES WITH SILICON -CONTAINING POLYMER MATRIX**

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#### **Abstract**

Composites based on [methyl(phenyl)siloxane] resins and carbon fibres as reinforcing elements have been investigated. Two types of [methyl(phenyl)siloxane] resins as matrix precursors and two types of carbon fibres (with sizing and without sizing) were used. Wet – winding technique was employed to prepare the prepregs. Unidirectional composite samples with organic matrix were subjected to thermal treatment to 1000oC. After the first step of heat treatment the porous samples were subjected to further densification by impregnation - heat treatment cycles. The influence of conditions of thermal treatment and densification on the mechanical properties of composites was studied.

**KEYWORDS:** polysiloxane, polymer precursors, ceramic composites

**THE EFFECT OF THE THERMAL TREATMENT OF THE MATRIX ON ITS MECHANICAL PROPERTIES WITH COMPOSITES ON THE BASIS OF GLASS FIBRES AND A SILOXANE MATRIX**

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Abstract

The values of the tensile elasticity modulus  $E_m$  and the shearing elasticity modulus  $G_m$  of the matrix of the composites were calculated using analytical relations based on the micromechanics of the composite materials with regard to the fabric reinforcement. The experimental data needed for the calculations were obtained with composites on the basis of glass fabrics and a siloxane matrix, which were prepared at the temperatures of 400 and 700 °C, by the method of resonance frequencies. The calculated values of the tensile elasticity modulus  $E_m$  and the shearing elasticity modulus  $G_m$  exhibit a rather good correspondence in the relative increase in their values.

**KEYWORDS:** composites, matrix, calculation of  $E_m$  and  $G_m$

**TRANSFORMATION OF POLYMETHYLPHENYLSILOXANES TO SILICONOXYCARBIDE GLASSES**

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Abstract

Silicon oxycarbides are modified quartz glasses, where some oxygen atoms are substituted by carbons. Likewise, some part of polyaromatic structures, so called "free carbon", dispersed in the material is present. The lower fraction of the structures the better for high temperature application in oxygen atmosphere. The precursor type and treatment conditions have principal influence on free carbon fraction.

The oxycarbides were prepared by pyrolysis of polysiloxanes with different content of methyl and phenyl groups. Preparation of silicon oxycarbide glasses and structure changes of polysiloxane precursors during heat treatment in nitrogen atmosphere were studied. The "free carbon phase" was concentrated by hydrofluoric acid treatment.

**KEYWORDS:** polysiloxane, pyrolysis, silicon oxycarbide

## STRUCTURAL CHARACTERIZATION OF THE FREE CARBON PHASE OF SILICON OXYCARBIDES PRODUCED BY POLYSILOXANE PYROLYSIS

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Abstract

Structure of the free carbon phase in three silicon oxycarbides was studied by FTIR and Raman spectroscopies, and by XRD. The oxycarbides were produced by pyrolysis of polysiloxanes with different content of methyl/phenyl groups at 1000 °C under nitrogen atmosphere. The free carbon phase was concentrated by treatment with hydrofluoric acid. The free carbon phase is formed by sp<sup>2</sup> graphene planes merged in sp<sup>3</sup> structures. Its content and positioning in the SiOC network and its structural pattern reflects the sp<sup>2</sup>/sp<sup>3</sup> ratio of the source polysiloxanes.

**KEYWORDS:** silicon oxycarbides, free carbon phase, FTIR and Raman spectroscopies, XRD

## CARBON FIBERS FROM TODAY'S VIEWPOINT

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Abstract

Short history and mechanical properties summary of nowadays carbon fibers (CF) is given. Problems of fiber mechanical properties measuring are discussed together with possibilities of surface characterization. Possible CF future application is mentioned.

**KEYWORDS:** Carbon fibers; VGCF; carbon nanotubes; mechanical properties; surface characterization.

## A NEURAL NETWORK METHOD TO PREDICTION OF CAKING PROPERTIES OF

## **COAL BASED ON THEIR PETROGRAPHIC AND CHEMICAL PROPERTIES**

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Abstract

There has been presented the opportunity for predicting caking properties of bituminous coking coals due to petrographic characteristics, physical and chemical properties at use of neuron networks. A neural network model was trained, verified and tested for samples obtained in separation of heavy liquids, what extended significantly a range of variability of parameters subject to analyzing, and for commercial samples of coals from the Upper Silesia Basin, as well. It has been proved that a share of basic groups of macerals and vitrinite reflectance are not sufficient parameters to forecast caking properties with satisfactory accuracy. Much more information is provided by parameters like the content of moisture, ash, volatile matter, carbon and hydrogen.

**KEYWORDS:** petrographic analysis, vitrinite reflectance, caking properties, neural networks

## **EFFECT OF PRESSURE AND TEMPERATURE ON COAL BEHAVIOUR IN PFBC/G**

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Abstract

New, efficient clean coal technologies involve pressurized combustion/gasification. The basic phenomena in coal combustion - i.e. devolatilization, ignition, clean coal technologies and burn out of coal/char particles and their dependence on temperature, pressure and coal particle properties have been studied by both TG analyses and by "in situ" fluidized bed combustion/gasification. Three subbituminous coals/lignites differing in volatile and ash contents have been explored.

Devolatilization of reactive coals/lignites in fluidized bed combustion is coupled with combustion and is very fast. Decisive effects are exerted by oxygen partial pressure and temperature. Gasification by CO<sub>2</sub> revealed decisive effect of temperature and ash catalysis on the process. Influence of CO<sub>2</sub> partial pressure or total pressure with the same volumetric concentration was found weaker. The main reason for such behaviour is probably unfavourable effect of total pressure on gasification equilibrium and particle temperature. Fluidized bed combustion of coal in terms of burn out times has shown very substantial effect of increasing oxygen partial pressure and temperature on combustion rate (burn out time). Effect of operating pressure on combustion rate is bigger for less reactive coals. At higher operating pressures, the burn out times are shorter, particle temperatures are higher, but entrainment of small particles is more intensive at comparable gas linear velocities. Effect of temperature and operating pressure depends on regime of combustion (reaction rate or diffusion processes as the rate limiting factors).

**KEYWORDS:** clean coal technology, clean coal technologies, fluidized bed, gasification

## **A KINETIC STUDY OF REACTIONS OF COAL WITH POLYPROPYLENE AND**

## POLYSTYRENE

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### Abstract

Kinetics of reactions of coal with polypropylene and polystyrene by means of TGA and DSC methods was studied. In the range of about 350–550 C a thermal decomposition of coal proceeds. Simultaneously, decomposition of polypropylene occurs (300 – 500 C) and hydrocarbons C<sub>2</sub> – C<sub>4</sub> as gas products are formed. The presence of coal facilitates the melting of polypropylene and enhances its decomposition, therefore, the yield of hydrocarbons C<sub>2</sub> – C<sub>4</sub> rises. In the case of polystyrene not only its decomposition but also reactions with coal proceed and new aromatics are formed. The yield of tar from copyrolysis is then higher in comparison with pyrolysis of coal alone. On the basis of the TGA and DCS measurements, reaction order, parameters of Arrhenius plot, time of completion, temperature of maximum decomposition and the rate of decomposition were evaluated and discussed.

**KEYWORDS:** coal, kinetics, polypropylene, polystyrene

## CO<sub>2</sub> EMISSION MONITORING

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### Abstract

Paper deals with CO<sub>2</sub> emission monitoring from coal combustion based on fuel consumption data. In this case, quality of monitoring is affected mainly on properly estimated value of Carbon Emission Factor (CEFs), which depends on coal type. Paper is focused on estimation of generally valid results, which can be used both for national inventory of CO<sub>2</sub> emissions and for monitoring of individual sources. In principal it is possible to use CEFs values defined using either net or gross calorific values. Pros and cons of using both possible definitions are discussed. The possibility of finding generally valid parameters is shown as a result of sound linear correlation between carbon and energy content (NCV, GCV) that is valid for coals of different rank (from lignite to hard coal). This correlation seems to be of general validity. Similar linear correlation was found between GCV and NCV data, which makes possible to mutually convert CEFs based on GCV and NCV respectively.

**KEYWORDS:** greenhouse gas emissions, IPCC methodology, carbon emission factors, carbon dioxide, fuel combustion, coal and lignite, net calorific values, gross heating values, correlation of coal characteristics, CO<sub>2</sub> emission monitoring, emission inventory