The Surface Effects Influence on Magnetic Resonance in Carbonizate

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The analysis of the "astronium" carbonizate powder surfaces with different particle dimensions are carried out. The behaviors of surface paramagnetic centers have been investigated by EPR method, it was established, that this behaviors depends on nature of the surfaces. The correlation of spin-lattice relaxation time of ^{3}He nuclei and concentration of paramagnetic centers on surface of carbonizate was found

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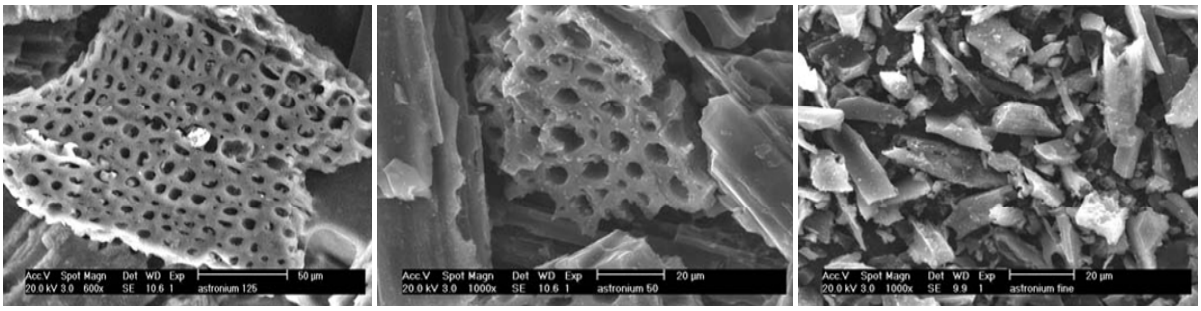
One of the main problems in medicine today is diagnostic of human lungs illnesses at the early stage of their evolution. When the NMR tomography is used, lungs cavities are filled up with noble gas (usually ^{3}He or ^{129}Xe) mixtured with oxygen. But for good resolution of NMR-image the gas should be hyperpolarized. There are several methods of hyperpolarized noble gas production (laser-pumping, brute-force polarization). The first method have low efficiency, the second one is high expensive.



125-150 μm 50-75 μm less 10 μm

Fig.1 Images of powder surfaces of carbonizate "astronium" with three different characteristic particle dimensions.

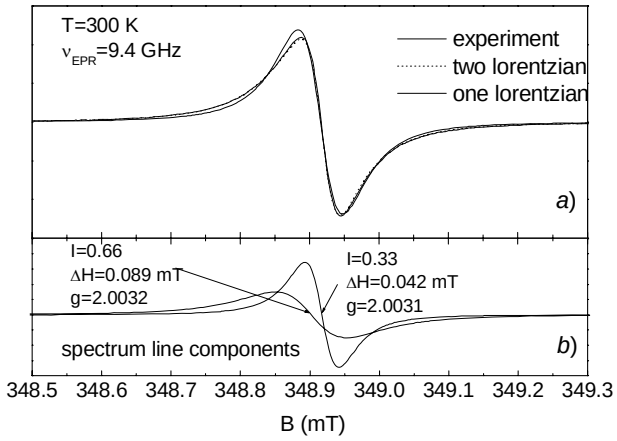


Fig.2 Approximation EPR spectra by two Lorentz curve

One of the perspective methods of noble gas production can be the dynamic polarization of the noble gas. Solid substance with developed surface and big quantity of absorbed noble gas atoms need for the realization of the method. In this case the polarization can transfer from the electron subsystem of the solid substance to the nuclear subsystem of the gas. The main problem now is finding of solid substance with best properties to the method of dynamic polarization of the gas.

The sample prepared from the tree called «astronium» has been studied. High porous structure characterizes this tree wood. The wood transformed to the coal by pyrolysis and the coal was mill for increasing of area of the surface interacting with the gas. In previous works, the behaviors of paramagnetic centers on the coal surface from dimension of powder particle were established [1–3].

The images of the surfaces of samples with three characteristic dimensions were obtained by electron scanning microscope Philips XL30ESEM (Fig.1). One can see that the samples with particle dimensions 50-75 μm and 125-150 μm have porous structure, while pores are destroyed in the sample with particle dimensions less then 10 μm. The rate between pore's surfaces and common surface's areas differ for each sample and the behaviors of surface's paramagnetic centers can be change.

The behaviors of paramagnetic centers were investigated by EPR. All measurements were made on the X-band commercial spectrometer ESP-300 Bruker at room temperature. Samples are pumping for remove oxygen molecules

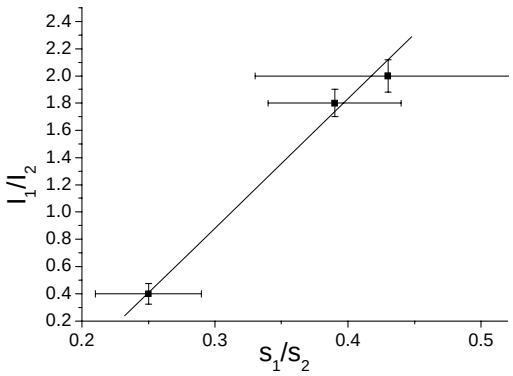


Fig.3 Correlation of two line intensities rate and two surface types areas: the area of break (s_1) and the area of pores(s_2)

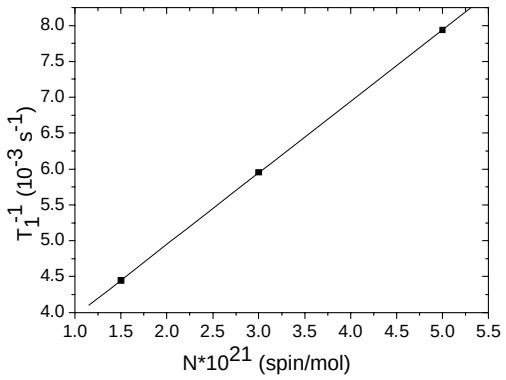


Fig.4 Correlation of ^{3}He nuclei spin-relaxation time and concentration of surface paramagnetic centers

from surface (the residual pressure less 10^{-4} torr). Asymmetric EPR signal with g-factor 2.0023 was observed in each

sample (Fig.2). The EPR line is narrow and linewidth is near 0.4 gauss. The line narrowing is caused by exchange interaction between paramagnetic centers on the surfaces of coal [4,5]. The shape of line can be approximated by two Lorentz lines with different intensities, linewidths and g-factors. Linewidths of both lines are nearly similar for all three samples. But the ratio of line's intensities and consequently the ratio of concentrations of paramagnetic centers is different for samples with different dimension of powder particle. Accordingly two kinds of paramagnetic centers were observed on the surfaces of such coal. Also the ratio of areas of two types of surface is estimated on the images. There is the good correlation between these parameters (Fig.3). Hence the types of paramagnetic centers can be attached to types of surfaces. The narrow line relates to paramagnetic centers on the pores surface, while wide line relates to paramagnetic centers on surface of break powder particle.

The obtained values are in agreement with the ^{3}He NMR relaxation, when ^{3}He gas filled carbonizate powder. The correlation of spin-lattice relaxation time of ^{3}He nuclei and concentration of paramagnetic centers on the coal's surface (Fig.4) show, that the paramagnetic centers on the surface of such coal are the main channel of ^{3}He nuclear relaxation.

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