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IR-SPECTROSCOPIC STUDY OF THE RADIOLYSES PROCESS OF PHENOL-WATER- NANO- γ -Al₂O₃- SYSTEM

M.A. Gurbanov, U.A. Guliyeva, S.Z. Melikova, E.T. Abdullayev

Institute of Radiation Problems of ANAS, B.Vahabzade 9

m_gurbanov@mail.ru, ulviyegulieva13@gmail.com

Abstract: In this work, the mechanism of the processes in aqueous phenol solutions in the presence of nano- γ -Al₂O₃ was investigated. The IR- spectroscopic method was chosen as the research method. There are observed similar character peaks at the initial and irradiated samples in the region the 1000-600 cm⁻¹ decreases with increasing adsorbed dose. With increasing adsorbed the intensity of peaks decrease in the 3600-3200 cm⁻¹ region.

Keywords: γ -irradiation, nano- γ -Al₂O₃, IR- spectra, intense bands

1. Introduction

The effect of nanocatalysts to aqueous solutions of toxic components has been studied in various scientific works [1-5], as well as the effect of toxic components of nanoparticles on the radiolysis process explains with their catalytic and adsorption effects. It was determined, that in contrast to phenol molecules, on the surface of γ -Al₂O₃ nanoparticles during the radiolysis of aqueous phenol solutions, its transformation products-hydroquinone, pyrochatechol, hydroxyhydroquinone are adsorbed. The adsorption ratio of those aromatic compounds to the nanoparticles, indicating that the adsorption ratio increases with an increasing number of OH groups in these aromatic compounds[1]. For this reason, the influence of nanocatalysts on the radiolysis process of aqueous phenol solution causes a decrease in the rate of secondary reactions in a liquid medium as a result of the adsorption of two-chamber phenols.

In other words, the aqueous solutions of toxic components of nano- γ -Al₂O₃ encompass two processes, that depending on each other.

As given in the above, physicochemical and chemical changes on the surface and liquid volume of the γ -Al₂O₃ nanoparticles were studied in this article.

This work aims to study the mechanism of the processes in aqueous phenol solutions in the presence of nano- γ -Al₂O₃ using IR- spectroscopic methods.

2. Methodology

0.2 g nano- γ -Al₂O₃ (d=20 nm) powder has been added to the phenol solution (C=1x10⁻² M). The solutions were irradiated by γ -irradiation by of ⁶⁰Co isotope under static conditions, in glass ampoules at room temperature. The dose rate was determined by ferrosulfate dosimetry and was 0.22 Gy / sec.

Characteristics of nano- γ -Al₂O₃ are given in Table 1.

Table 1. Characteristics of nano- γ - Al_2O_3

Purification	99,99%
Content	White color nano-sized powder
Participle size D_{50}	20 nm
Special surface area	262,09 m^2/g
Gamma phase	99,32%
water	0,317%
Mix	Ca: 8,25 ppm; Fe: 7,967 ppm; K: 6,3 ppm; Na: 4,707 ppm; Si: 9,71 ppm

Centrifuge 5804R (Eppendorf) was used to separate the solid phase from the liquid phase. Irradiated samples (1 ml) are placed in a 50 ml cylindrical cradle with a rotation 5000 period/min speed. The rotation time was 5 minutes. The solid sediments were dried at room temperature for 2 days, then analyzed by mixing with KBr as shown in methodology. IR spectra of solid sediments obtained from the separation were recorded using Varian 640 FT-IR spectrometer in the region $4000\text{--}400\text{ cm}^{-1}$.

3. Conclusions and discussion

IR- adsorption spectrum of nano - γ - Al_2O_3 particle is given in fig.1.

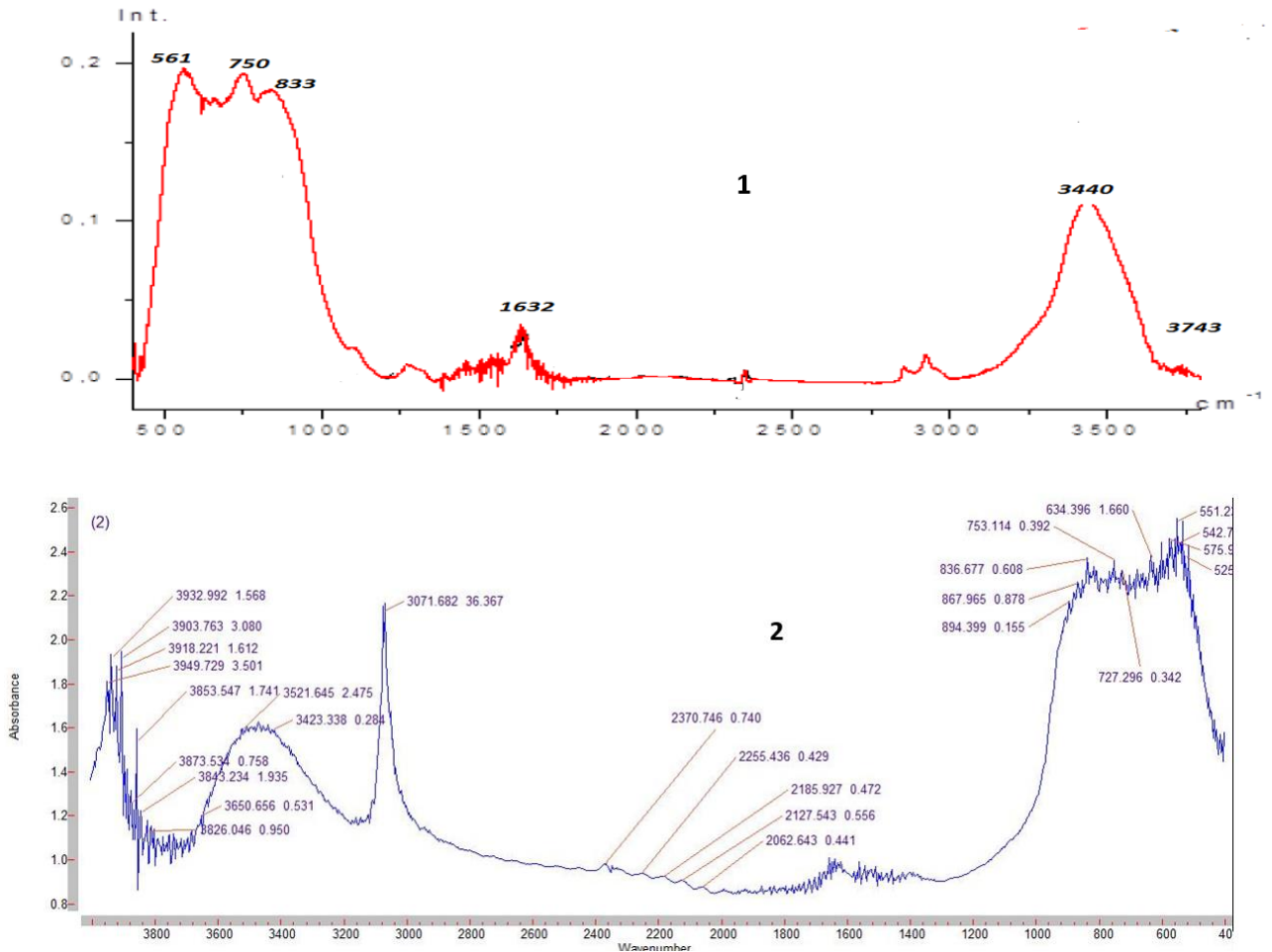
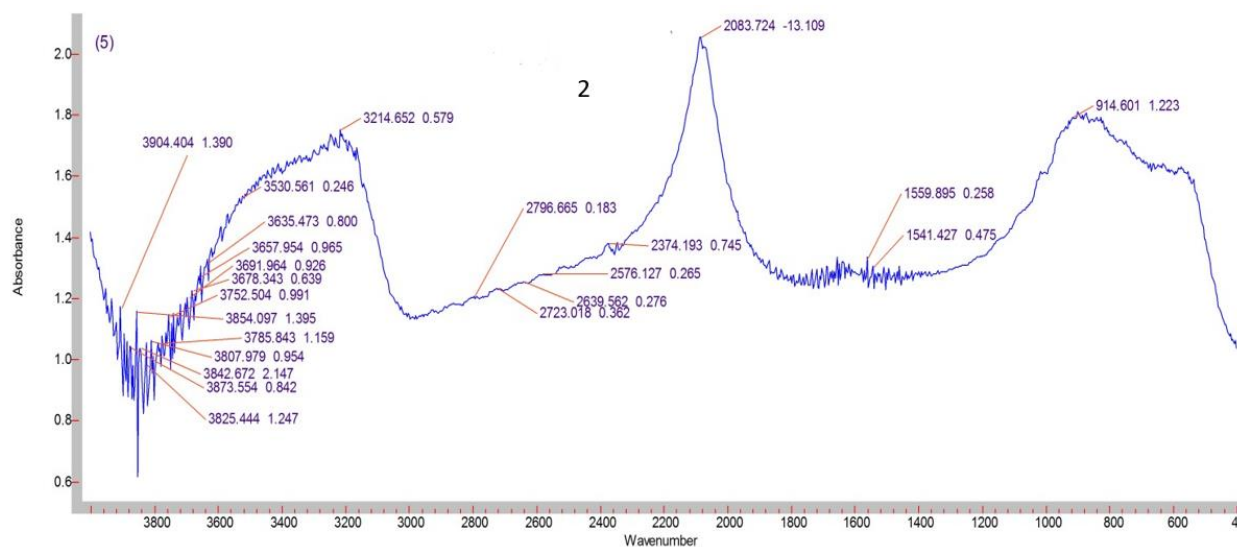
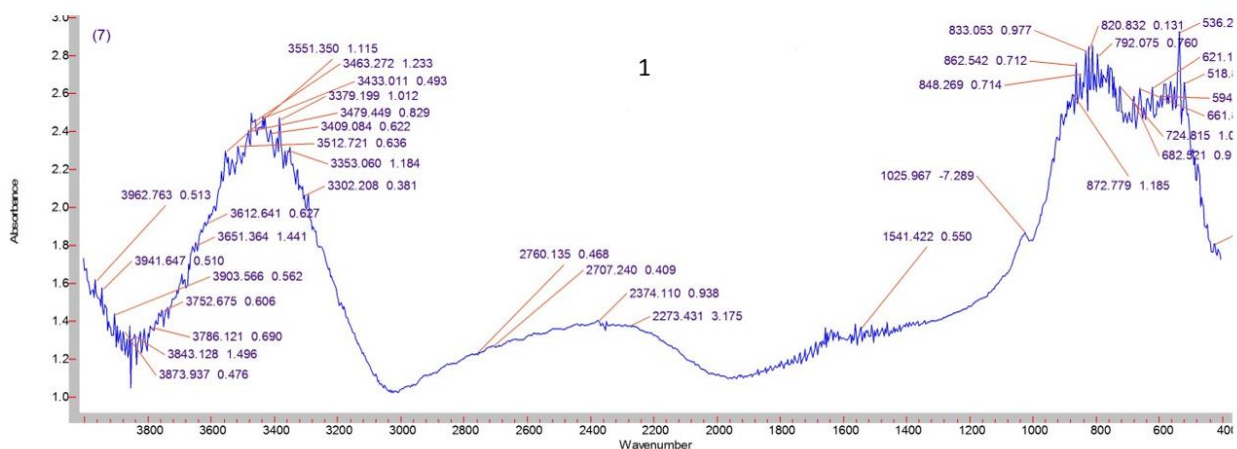


Fig.1. IR- adsorption spectrum of nano - γ - Al_2O_3 particle: 1-literature data, 2-practise

According to literature data, a large number of adsorbed water molecules are collected on the particle surface, causing intense bands in the region of deformation H – O – H (1632 cm^{-1}) and stretching vibrations (3400 cm^{-1}). Also on the surface of the sample, there are various types (isolated, associated with each other and associated with water) -OH groups ($3743, 3250\text{ cm}^{-1}$). Intense bands in the region of $400\text{--}800\text{ cm}^{-1}$ are due to the presence of Al – O bonds. Weak bands observing in the region of $2840\text{--}2960\text{ cm}^{-1}$ indicate trace amounts of organic matter, which, according to elemental analysis [6].

The IR spectra of the solid phase generated after centrifugation of the radiolysis of the aqueous phenol ($1 \times 10^{-2}\text{ M}$) solution in the presence nano- $\gamma\text{-Al}_2\text{O}_3$ particle (D=0-38-380 kGy) is given in fig.2.



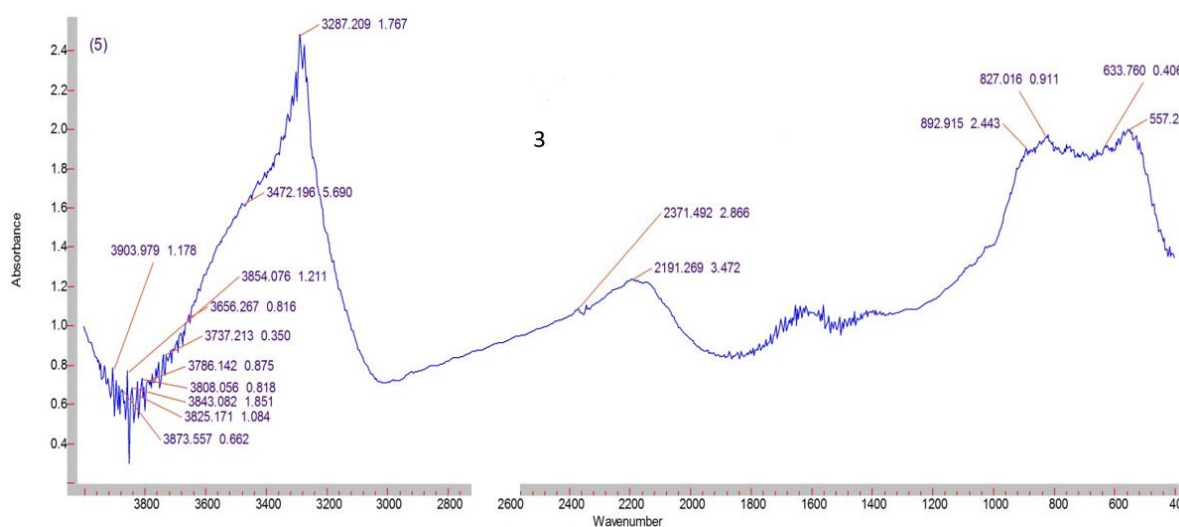


Fig. 2. The IR spectra of the solid phase generated after centrifugation of the radiolysis of the aqueous phenol ($1 \times 10^{-2} M$) solution in the presence of nano- γ - Al_2O_3 particle. 1-initial; 2-38 kGy; 3-380 kGy

As can be seen from fig. 2, at initial (1) and 38 kGy (2) in the $900-500 \text{ cm}^{-1}$ region observes active peaks. There are active peaks in irradiated samples in the region $2200-1800 \text{ cm}^{-1}$. With increasing adsorbed the intensity of peaks decreases in the $3600-3200 \text{ cm}^{-1}$ region as following:

$$1974 \text{ cm}^{-1} (\text{initial}) \rightarrow 2083 (38 \text{ kGy}) \rightarrow 2123 \text{ cm}^{-1} (380 \text{ kGy})$$

There are observes similar character peaks at the initial (1) and 38 kGy (2) irradiated samples in the region the $1000-600 \text{ cm}^{-1}$ decreases with increasing dose. Peaks of the same nature are observed in the area of $1000-600 \text{ cm}^{-1}$ at the initial and 13 kGy

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ИК-СПЕКТРОСКОПИЧЕСКОЕ ИССЛЕДОВАНИЕ ПРОЦЕССА РАДИОЛИЗА СИСТЕМЫ ФЕНОЛ-ВОДА-НАНО- γ - Al_2O_3

М.А. Курбанов, У.А Кулиева, Меликова С.З, Э.Т. Абдуллаев

Резюме: В данной работе исследован механизм процессов водных растворах фенолов в присутствии нано- γ - Al_2O_3 . ИК- спектроскопический метод был выбран в качестве метода исследования. Наблюдаются похожие характерные пики на исходных (1) и 38 кГр (2) облученных образцах в области $1000-600\text{ см}^{-1}$, интенсивности пиков уменьшаются с увеличением поглощенной дозы. С увеличением поглощенной дозы интенсивность пиков уменьшается в области $3600-3200\text{ см}^{-1}$.

Ключевые слова: γ -облучение, нано- γ - Al_2O_3 , ИК-спектры, интенсивные полосы

FENOL-SU-NANO- γ - Al_2O_3 SİSTEMİNİN RADİOLİZ PROSESİNİN İQ- SPEKTROSKOPİK TƏDQIQI

М.Ə. Qurbanov, Ü.A. Quliyeva, S.Z. Məlikova, E.T. Abdullayev

Xülasə: Bu işdə nano- γ - Al_2O_3 iştirakında fenolun suda məhlulunda baş verən proseslərin mexanizmi öyrənilmişdir. Tədqiqat metodu kimi İQ- spektroskopik metod seçilmişdir. Nano- Al_2O_3 -ün ilkin (1) və 38 kQr (2) nümunələrində $1000-600\text{ sm}^{-1}$ oblastda piklərin intensivliyi udulma dozasının artması ilə azalır. Udulma dozasının artması ilə $3600-3200\text{ sm}^{-1}$ oblastda piklərin intensivliyi azalır.

Açar sözlər: γ -şüalanma, nано- γ - Al_2O_3 , IQ- spektrlər, intensiv zolaqlar