

**INFRARED SPECTRAL ANALYSIS OF GYPSUM CONCRETE MATERIALS**

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Abstract

This study investigates the infrared spectral characteristics of gypsum concrete materials prepared using lime waste and Redispersible Polymer Powder (RPP). The objective was to determine the changes occurring in the mineralogical and chemical composition of gypsum concrete after the addition of 1% RPP. Infrared spectroscopy was applied to compare gypsum concrete specimens prepared without RPP and with 1% RPP. The obtained spectra revealed significant changes in the absorption bands located at $2343\text{--}2358\text{ cm}^{-1}$, $2850\text{--}2922\text{ cm}^{-1}$, and 3390 cm^{-1} . The appearance of new absorption peaks and the increase in their intensity indicate the formation of new mineral phases and stronger chemical bonds. The bands observed in the regions of $596\text{--}665\text{ cm}^{-1}$, $877\text{--}1111\text{ cm}^{-1}$, and $1465\text{--}1683\text{ cm}^{-1}$ correspond to silicates, carbonates, and water-related functional groups. The increase in the intensity of OH-group vibrations and polymer-related absorption bands confirms the enhanced degree of polymerization and hydration in the modified gypsum concrete. The results demonstrate that the incorporation of 1% RPP into lime-waste-based gypsum concrete contributes to the formation of high-strength compounds and improves the structural properties of the material.

Keywords: Gypsum concrete, lime waste, Redispersible Polymer Powder, infrared spectroscopy, absorption bands, polymerization, hydration, silicates, carbonates, mineral phases, gypsum binder, structural properties.

Introduction

The main purpose of the infrared spectral method was to compare the substances present in gypsum concrete materials with one another. In this study, the infrared spectral method was used to determine the changes occurring through comparison of the infrared spectra of gypsum concrete materials prepared on the basis of lime waste without the addition of Redispersible Polymer Powder (RPP), and gypsum concrete materials prepared on the basis of lime waste with the addition of 1% Redispersible Polymer Powder (RPP).

The images obtained as a result of the infrared spectrogram are presented in Figure 1.

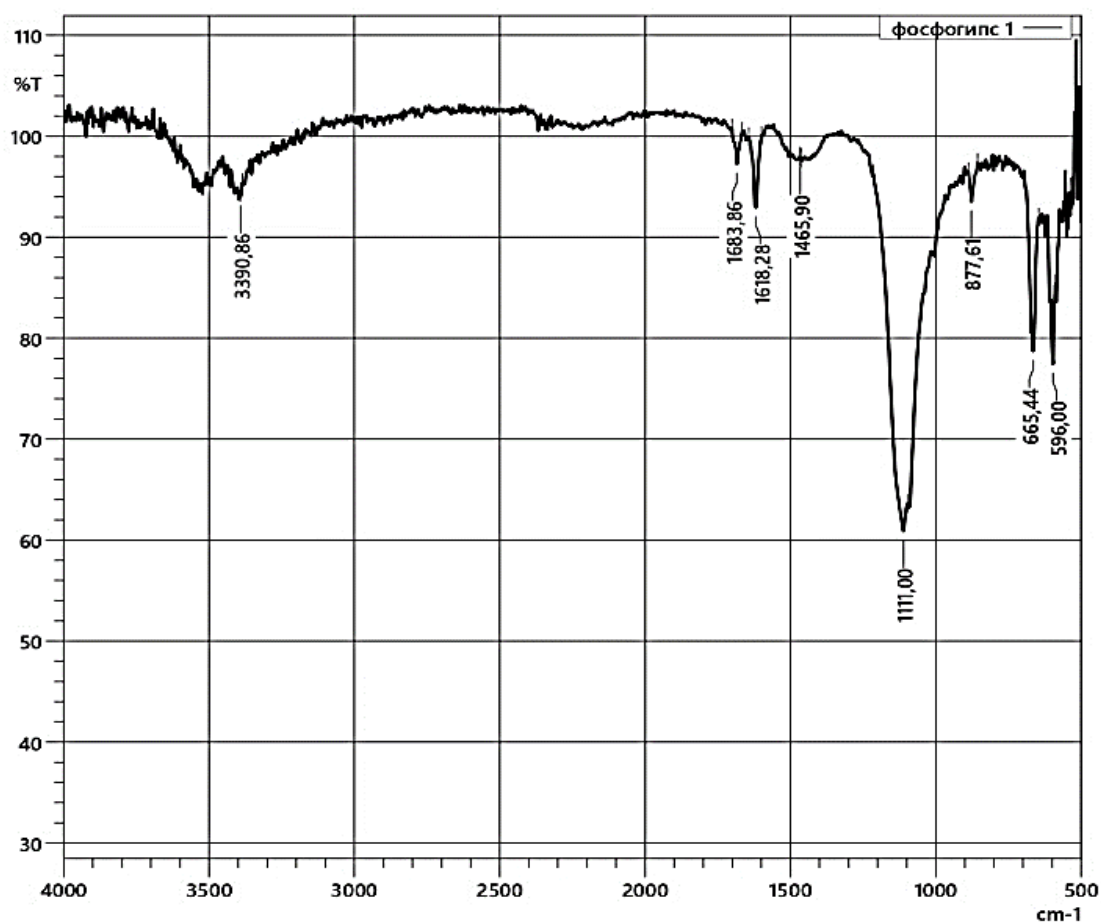


Figure 1. Infrared spectral analysis of gypsum concrete material without the addition of Redispersible Polymer Powder (RPP).

In the spectrogram shown in Figure 1, the curve of the gypsum concrete material prepared on the basis of lime waste without the addition of Redispersible Polymer Powder (RPP) exhibited vibrations in the regions of 2358.94 cm^{-1} , 2850.79 cm^{-1} , and 2922.16 cm^{-1} . The main changes were observed precisely in these regions after the addition of Redispersible Polymer Powder (RPP).

From the spectrogram in Figure 2, changes were observed in the curve of the gypsum concrete material prepared on the basis of lime waste with the addition of Redispersible Polymer Powder (RPP) in the regions of $2343.51\text{--}2358.94\text{ cm}^{-1}$ and $2850.79\text{--}2922.16\text{ cm}^{-1}$. In the 3390.86 cm^{-1} region of the spectrogram, a new vibration was formed due to the addition of Redispersible Polymer Powder (RPP), as a result of changes caused by the reaction of the carbon atoms in the carboxyl functional groups belonging to the NH^+ group in the lime waste composition with other minerals. The changes in these regions may be exemplified by newly formed minerals such as calcium hydroxide ($\text{Ca}(\text{OH})_2$), sodium (Na), aluminum (Al), and chlorine (Cl). Although the vibrations in spectrogram a) of Figure 1 were retained in spectrogram b), as in the previous samples, with reduced absorbance of substances in some regions, changes were also observed in the peaks of other regions, indicating the formation of new absorption peaks.

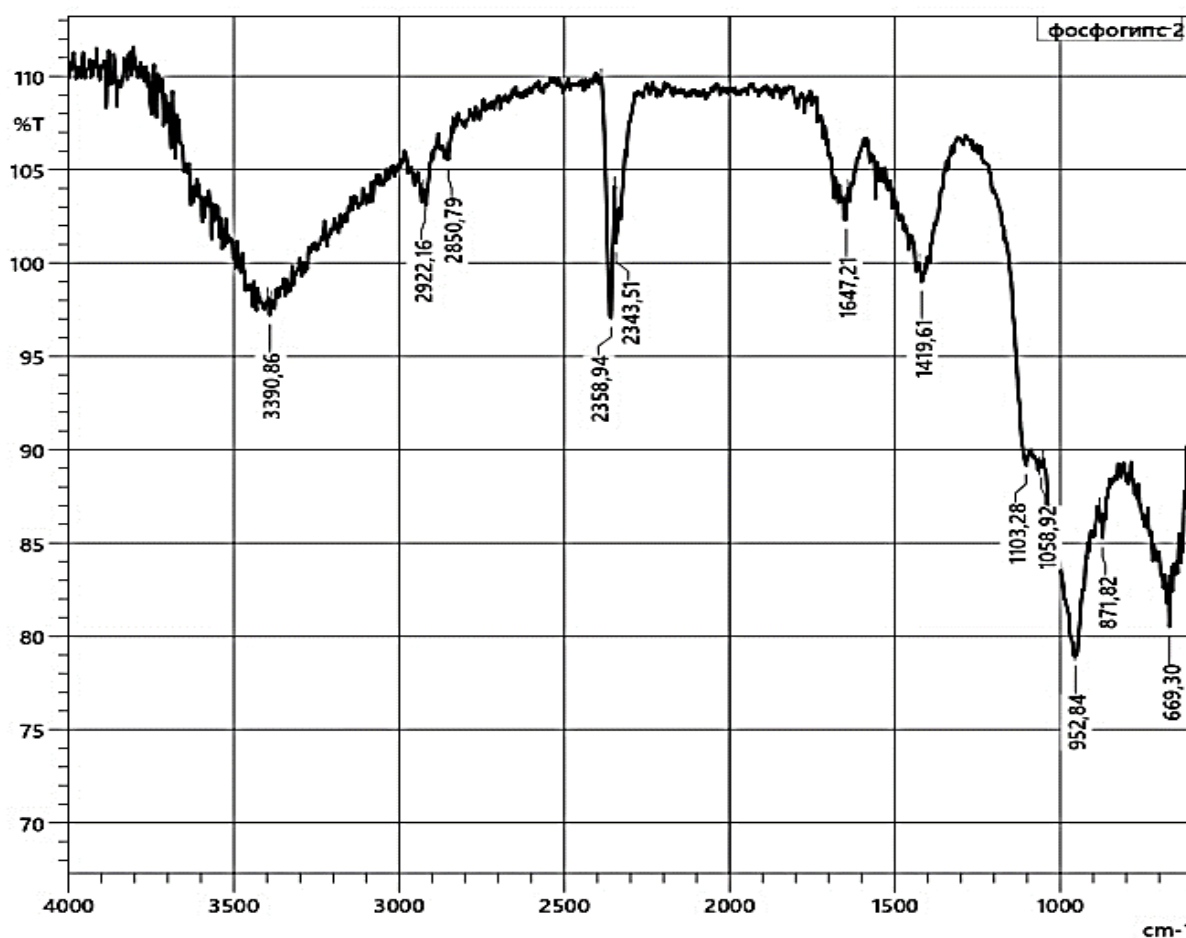


Figure 2. Infrared spectral analysis of gypsum concrete material with 1% Redispersible Polymer Powder (RPP).

According to Figure 2 above, the vibrations in the regions of 596.00 cm^{-1} and 665.44 cm^{-1} in the materials without Redispersible Polymer Powder (RPP) were confirmed by the absorption bands related to the formation of $\text{SO}_3\text{-NSO}_3\text{-}$ groups due to the addition of Redispersible Polymer Powder (RPP). The intensities in the 3390.86 cm^{-1} region of the spectrogram indicate a change in the coordination of bonding between the residues in the lime waste caused by the Redispersible Polymer Powder (RPP) additive. This demonstrates that the degree of polymerization of the Redispersible Polymer Powder (RPP) additive increased, while the high vibration values in these regions indicate the formation of high-strength compounds.

As a result of the infrared spectrogram, the absorption bands of water correspond to adsorbed water (2924 cm^{-1} and 3390 cm^{-1}), carbonates (1465 and 1683 cm^{-1}), and silicates ($877\text{--}1111\text{ cm}^{-1}$). The bands in the $596\text{--}665\text{ cm}^{-1}$ range correspond to the asymmetric and symmetric vibrations of silicon dioxide (Si-O) tetrahedra. The strong and broad band in the 3390 cm^{-1} range indicates the stretching and bending vibrations of the OH group in free and bound water.

Therefore, infrared spectroscopy showed the coordination changes during hydration, namely, the formation of OH groups in parallel with the transition from tetrahedral coordination compounds (non-hydrated minerals) to octahedral coordination compounds (hydrated phases). The absorption bands in

the regions of 871, 952, 1058, 1103, 2343, 2358, 2850, and 2922 cm^{-1} indicate the formation of minerals associated with the Redispersible Polymer Powder (RPP) additive (Figure 2).

According to the obtained infrared spectral analysis results, it can be observed that gypsum concrete materials prepared from lime waste, Redispersible Polymer Powder (RPP), and gypsum binder possess high strength, as evidenced by the high intensity of the absorption bands corresponding to minerals that ensure the strength of the material.

Conclusions

1. The infrared spectral analysis showed that the addition of 1% Redispersible Polymer Powder (RPP) to gypsum concrete prepared on the basis of lime waste caused significant changes in the absorption bands.
2. The main changes were observed in the regions of 2343–2358 cm^{-1} and 2850–2922 cm^{-1} , indicating the formation of new chemical bonds and mineral phases after the addition of RPP.
3. A new vibration band appeared at 3390 cm^{-1} , which is associated with OH groups and the interaction of carboxyl functional groups with mineral components.
4. The increase in intensity at 3390 cm^{-1} indicates improved coordination and stronger bonding between the lime waste particles and the polymer additive.
5. The absorption bands in the range of 596–665 cm^{-1} correspond to Si–O tetrahedral vibrations and $\text{SO}_3\text{--NSO}_3\text{--}$ groups, confirming the participation of silicate and sulfate-containing compounds in the structure formation process.

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