# SYNTHESIS AND STUDY OF ORGANOSILICON COMPOUNDS BASED ON SODIUM METASILICATE AND DICHLOROHYDRIN

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***Abstract.*** *In this work, a new organosilicon oligomer based on sodium metasilicate and 1,3-dichlorohydrin was synthesized, its structure and physicochemical properties were studied. It was shown that the resulting organosilicon compound has the potential to be used as a hydrophobic modifier for building materials, an additive to reduce water absorption in concrete and gypsum compositions, and as a component of fire-resistant coatings.*

***Keywords:*** *sodium metasilicate, dichlorohydrin, organosilicon oligomer, hydrophobic modifier, fire-resistant coating.*

**Introduction.** The synthesis was carried out in a 150 ml stainless-steel autoclave capable of withstanding pressures up to 10 atm. 1,3-Dichlorohydrin and sodium metasilicate were used in different molar ratios (1:1 and 1:2). The reactants were first completely dissolved in DMSO and homogenized by magnetic stirring at 600 rpm for 15 minutes. The resulting mixture was transferred to the autoclave, tightly sealed, and maintained at 100 ± 5°C under a pressure of 3-5 atm for 6-8 hours.

After completion of the reaction, the autoclave was allowed to cool naturally to room temperature. The reaction mixture was then filtered under vacuum, and the by-product sodium chloride was completely removed by thorough washing. The purified product was dried in a vacuum oven at 80°C for 12 hours.

The functional groups and chemical bonds of the obtained compound were identified by Fourier-transform infrared spectroscopy (FTIR). The reaction yielded an organosilicon oligomer belonging to the polybis(2-hydroxypropoxy)silanediyl series, which exhibited pronounced hydrophobic properties.

To optimize the reaction conditions, a series of experiments was conducted varying the temperature (80°C and 100°C), reactant molar ratio, and presence of 0.5 wt.% CuI catalyst. The highest yield (90%) was achieved at 100°C with a 1,3-dichlorohydrin : sodium metasilicate molar ratio of 1:2 and a reaction time of 6-8 hours.

**Table 1**

**Factors affecting the reaction of sodium metasilicate and dichlorohydrin**

| Mole ratio * | Temperature (°C) | Catalyst (CuI, %) | Reaction yield (%) |
|---|---|---|---|
| 1:1 | 80 | 0,5 | 48 |
| 1:2 | 80 | 0,5 | 53 |
| 1:1 | 100 | 0,5 | 58 |
| 1:2 | 100 | 0,5 | 57 |

*-($C_3H_5Cl_2OH$:$Na_2SiO_3$)

The highest yield was achieved with a CuI catalyst at a 1:1 molar ratio and a temperature of 100°C, with a reaction time of 8 hours.

The physicochemical properties of this compound, synthesized from sodium metasilicate and dichlorohydrin, were studied by IR spectroscopy.

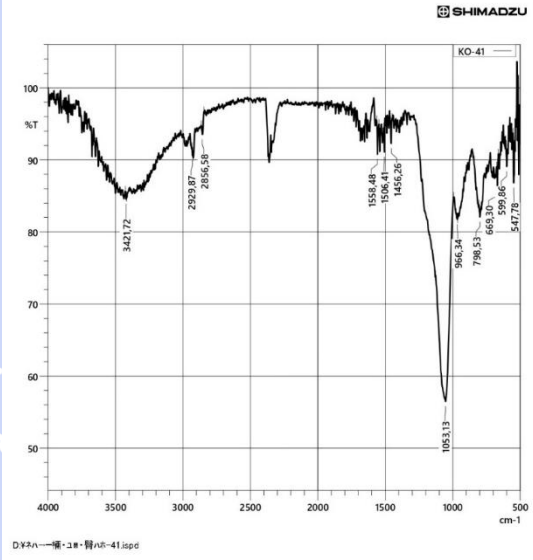


**Figure 1. IR spectroscopic analysis of an organosilicon compound synthesized from sodium metasilicate and dichlorohydrin**

The FTIR spectrum presented in Figure 1 unambiguously confirms the successful reaction between sodium metasilicate and 1,3-dichlorohydrin. The synthesized compound can be represented by the structural formula $Cl[CH_2\text{-}CH(OH)\text{-}CH_2\text{-}O\text{-}Si(=O)\text{-}O\text{-}CH_2\text{-}CH(OH)\text{-}CH_2]_nCl$.

The main characteristic bands are interpreted as follows: A broad and intense absorption centered at 3427.12 $cm^{-1}$ corresponds to O-H stretching vibrations of hydroxyl groups in the polymer chain, originating from the secondary alcohol moieties of the glycerin residues derived from 1,3-dichlorohydrin. Doublet bands at 2942.95 $cm^{-1}$ and 2895.98 $cm^{-1}$ are attributed to asymmetric and symmetric C-H stretching vibrations of -$CH_2$- groups, confirming the presence of alkyl fragments in the organic chain. The distinct band at 1252.84 $cm^{-1}$ is due to C-O stretching of the ether linkage,

evidencing the formation of Si-O-C bonds between dichlorohydrin and silicate anions. The strongest and broadest band at 1053.13 $cm^{-1}$ is characteristic of asymmetric Si-O stretching, representing the siloxane (Si-O-Si) backbone derived from sodium metasilicate and confirming the occurrence of polycondensation with formation of a siloxane network. Medium-intensity bands at 693.30 $cm^{-1}$ and 547.78 $cm^{-1}$ correspond to stretching and deformation vibrations of C-Cl bonds, proving that terminal chlorine atoms are retained and that a chlorine-terminated oligomer/polymer has been obtained.

All observed characteristic bands are in full agreement with the proposed structural formula, conclusively demonstrating that both nucleophilic substitution and subsequent condensation reactions between sodium metasilicate and 1,3-dichlorohydrin proceeded successfully.

**Conclusion.** A novel organosilicon oligomer with the formula $Cl[CH_2\text{-}CH(OH)\text{-}CH_2\text{-}O\text{-}Si(=O)\text{-}O\text{-}CH_2\text{-}CH(OH)\text{-}CH_2]_nCl$ was successfully synthesized from sodium metasilicate and 1,3-dichlorohydrin. Under optimal conditions (100°C, 1:2 molar ratio, 0.5% CuI, 6-8 h), the product yield reached 90%. FTIR spectroscopy and thermogravimetric analysis fully confirmed the structure of the product and revealed its high hydrophobicity and thermal stability. The obtained compound shows excellent potential as an effective hydrophobizing and fire-resistant modifier for construction materials.

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