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SYNTHESIS AND STRUCTURE OF DIFFERENT-LIGAND AND
DIFFERENT-METAL GERMANIUM (IV) COMPLEXES WITH MALIC
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In the course of the systematical research towards complex formation of germanium (IV) with hydroxycarboxylic acids, we have previously synthesized and characterized structurally different-ligand and heteronuclear coordination compounds with citric, tartaric and xylaric acids. To continue the research as one of the most interesting versatile polydentate ligand we have chosen the malic acid, which plays the key role in metabolism of plants and animals, and is involved in many biochemical processes, e.g., the Krebs cycle.

By the method of self-assembly the different-ligand compound [Ge(HMal)₂(phen)]·phen·2H₂O (**I**) (H₃Mal is a malic acid, phen is a 1,10'-phenanthroline) from the water solution and by the method of stepwise synthesis the different-metal compound [CuCl(phen)₂][Ge(OH)(HMal)₂] (**II**) from the water-ethylene solution were synthesized. Compounds were characterized by elemental analysis, IR-spectroscopy, thermogravimetry and X-ray diffraction.

The presence in IR spectra of **I** and **II** $\nu(\text{C}=\text{O})$, $\nu_{\text{as}}(\text{COO}^-)$ and $\nu_{\text{s}}(\text{COO}^-)$ absorption bands, which are typical for COOH and COO⁻ groups, shows the presence in the complexes of nonequivalent carboxyl groups (free and bound). The conclusion about how these groups are bonded with germanium is also made on the basis of the band corresponding to the Ge–O stretching vibrations, which is emergence in the IR spectra of complexes. The presence of the band responsible for the Ge–O–H bending vibrations implies the presence of the hydrolyzed form of germanium in the complex **II**. In the structures of complexes **I** and **II** two different forms of Germanium are implemented: Ge⁴⁺ (**I**) and hydrolyzed GeOH³⁺ (**II**), wherein neutral complex and anion are formed respectively. In **I** coordination number is 6, in **II** – 5, where Germanium atom is coordinated with two malate anions HMal²⁻ in both cases and binds with 1,10'-phenanthroline in **I** and with hydroxyl group in **II**. The negative charge of complex anion [Ge(OH)(HMal)₂]⁻ in structure **II** is compensated with the complex cation [CuCl(phen)₂]⁺. The coordination polyhedron of Ge atom in anion is pyramid with distorted square in the base.