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Sodium tetrahydroxoplumbate $Na_2[Pb(OH)_6]$: synthesis, structure, and properties

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Abstract

By the interaction of lead dioxide, sodium hydroxide and water, sodium tetrahydroxoplumbate(IV) of the composition $Na_2[Pb(OH)_6]$ was isolated in the form of single crystals sized up to 2.0 mm. The compound was identified by a set of methods: chemical analysis, optical analysis, X-ray powder analysis, X-ray single crystal analysis, IR spectroscopy, thermogravimetric analysis. The picnometric density was measured as 3.92 g/cm^3. $Na_2[Pb(OH)_6]$ crystallizes as transparent colorless anisotropic single axis and optically positive crystals. Mean transmittance coefficient 1.684±0.005. The X-ray gramme was indecied as a hexagonal symmetry with the call parameters: a = 6.020±0.09 Å; c = 14.22±0.02 Å; V = 446 Å^3. The corresponding parameters found by the X-ray single crystal analysis were detected as following: a = 6.0361±0.0005 Å, c = 14.253±0.002 Å, V = 449.72±0.09 Å^3 with three molecules in a unit sell; space group $R\bar{3}$. The base of the crystal structure are almost regular lead-oxygen octahedra and sodium cations which are posed in the way that oxygen atoms also form an octahedron around each Na^+ species. Sodium-oxygen octahedra are distorted. Two crystallographically unequivalent sodium atoms are localized in the octahedra with the different interatomic Na–O distances: 2.419(11) Å and 2.423(11) Å, respectively. Lead-oxygen octahedra are characterized by the six same Pb–O distances (2.165(10) Å, and valence angles $O–Pb–O^*$ 93.3(4)^o and $O^*–Pb–O^{**}$ 86.7(4)^o. The lead- and sodium-oxygen octahedra form unlimited layers along the *Z*-axis. The O–H bond length in the hydroxyl-group equals 0.85 Å. The O–H bond vector is perpendicular to the plane of the lead-sodium-oxygen layer. Thus, the layers interact with each other through the hydrogen bonds in the way that each OH group acts both as hydrogen donor and hydrogen acceptor. The thermolysis of $Na_2[Pb(OH)_6]$ proceeds in the temperature interval from 140 to 570 ºC in two stages according to the scheme: $2Na_2[Pb(OH)_6] \rightarrow Na_2Pb_2O_5 + 2NaOH \rightarrow 2Na_2PbO_3$. As a result, the β-Na_2PbO_3 modification is formed. The mentioned compound is also thermically unstable, and decomposes at 890 ^{o}C with the release of oxygen.

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