**Molecular Dynamics Simulation of [CuCl2(1,2-diaminoethane)n] (n = 1, 2) complexes in aqueous solution**

Yefimova Irina, yefir2000@gmail.com

Scientific supervisor: Dr. Komolkin A. V., Department of Nuclear-Physical Research Methods, Faculty of Physics, Saint-Petersburg State University

**Introduction**

Medical research shows that many anticancer, antiviral and antiseptic agents work by binding to DNA. This can damage the DNA of cancer cells and kill them [1]. The use of metal-based drugs with transition metals, like Cu (II) or Zn (II), presents the most important strategy in the development of new anticancer and antimicrobial agents [2].

Selection of suitable Force Fields for Molecular Dynamics simulation of EDA-Cu2+·2Cl– and EDA2-Cu2+·2Cl– complexes in aqueous solution could be used in further research of anticancer drugs.

**Simulation of [EDA2-Cu2+]·2Cl– planar complex**

The Jmol program was used to create a model of the ethylenediamine (EDA) molecule (H2NCH2CH2NH2) [3].

Force Fields for Molecular Dynamics have been chosen for aqua SPC/E (OPLS-AA) [4], for EDA molecules and Cl– ions – OPLS-AA. CHARMM 27 has been chosen for Cu2+ ion.

If molecules of EDA were placed in the same plane, then they would start rotate. It shown in figure 8. While modeling all EDA molecules one by one separated from the Cu2 + ion (fig. 2).

|  |  |
| --- | --- |
| D:\1Lетопись\2к\Курсовая\Cu-2en-planar\Eda-002259.2.jpg | D:\1Lетопись\2к\Курсовая\Cu-2en-planar\Eda-001659.2.jpg |
| Fig. 1 Rotation of EDA molecule around Cu2+ ion |

|  |  |
| --- | --- |
| D:\1Lетопись\2к\Курсовая\Cu-2en-planar\отрыв1.jpg | D:\1Lетопись\2к\Курсовая\Cu-2en-planar\отрыв2.jpg |
| Fig. 2 Separation of EDA molecules from Cu2+ ion |

There were 3 or 4 aqua molecules in a solvation shell of Cu2+ ion in different moments. The number of molecules depends on the timing of simulation. Therefore, it can vary within one molecule.

It can be seen in figures 1 and 2 that Cl– ions did not included in solvation shell of Cu2+ ion. They formed a solvent-separated ion-pair.

For long-term simulation of complex, EDA molecules left it. And aqua molecules have taken their place. So, there were 7 aqua molecules surround Cu2+ ion.

**Results**

The obtained value of number of molecules in Cu2+ ion solvation shell was not expected. The expected value was 6 aqua molecules [5]. However, in simulation there were 7 or 8 aqua molecules, considering their mobility.

For long-term simulation of [EDA2-Cu2+] complex, EDA molecules left it. There was a dissociation of the complex. However, according to EPR research [6] Cu2+ ion solvation shell contains nitrogen atoms.

This can be explained by the choice of Molecular Dynamics parameters of Cu2+ ion. The selected parameters are probably not suitable for this complex.

**References**:

1. N. Raman, A. Selvan, S. Sudharsan. Metallation of ethylenediamine based Schiff base with biologically active Cu(II), Ni(II) and Zn(II) ions: Synthesis, spectroscopic characterization, electrochemical behaviour, DNA binding, photonuclease activity and in vitro antimicrobial efficacy // Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy. V. 79. No 5. September 2011. P. 873-883.
2. J.G. Liu, B.H. Ye, H. Li, Q.X. Zhen, L.N. Ji, Y.H. Fu. Polypyridyl ruthenium (II) complexes containing intramolecular hydrogen-bond ligand: syntheses, characterization, and DNA-binding properties // J. Inorg. Biochem. 1999. V. 76 No. 3. P. 265–271.
3. Jmol: an open-source browser-based HTML5 viewer and stand-alone Java viewer for chemical structures in 3D. URL: http://jmol.sourceforge.net/ (accessed 07.05.2020).
4. William L. Jorgensen Research Group — OPLS-AA. URL: http://zarbi.chem.yale.edu/oplsaam.html (accessed 07.05.2020).
5. Vyacheslav S. Bryantsev, Mamadou S. Diallo, Adri C. T. van Duin, and William A. Goddard III. Hydration of Copper (II): New Insights from Density Functional Theory and the COSMO Solvation Model // J. Phys. Chem. 2008. V. 112. P. 9104–9112.
6. E. Selimović1, A. V. Komolkin, A. V. Egorov, T. Soldatović. The ligand substitution reactions of [CuCl2(terpy)] and [CuCl2(en)] complexes with bioligands by EPR spectroscopy // Conf. Спектроскопия координационных соединений. 2017.