Analysis of the effect of $AlCl_3$ and $FeCl_3$ concentration in BSA solutions on the parameters of film textures upon reaching the isoelectric point

D. Glibitskiy[1], O. Gorobchenko[2], O. Nikolov[2], T. Cheipesh[3], T. Dzhimieva[3,4], I. Zaitseva[4,5], A. Zibarov[6], A. Roshal[6], M. Semenov[1], A. Khrebtova[1], G. Glibitskiy[1]

[1] Department of biological physics, O.Ya. Usikov Institute for Radiophysics and Electronics, National Academy of Sciences of Ukraine, Kharkiv-61085, Ukraine.
[2] Department of molecular and medical biophysics, School of radiophysics, biomedical electronics and computer systems, V.N. Karazin Kharkiv National University, Kharkiv-61022, Ukraine.
[3] Chemical faculty, V.N. Karazin Kharkiv National University, Kharkiv-61022, Ukraine.
[4] V.N. Karazin Kharkiv National University, Kharkiv-61022, Ukraine.
[5] O.M. Beketov National University of Urban Economy, Kharkiv-61002, Ukraine.
[6] Institute for Chemistry, V.N. Karazin Kharkiv National University, Kharkiv-61022, Ukraine.

Introduction

Previously, we have presented a method for assessing the effect of physicochemical factors on biopolymers by analyzing textures on films resulting from their dried solutions [1]. The main parameters for describing textures in this method are the specific length L_{spec} and the number of segments N_{segm} of zigzag patterns (Fig. 1).

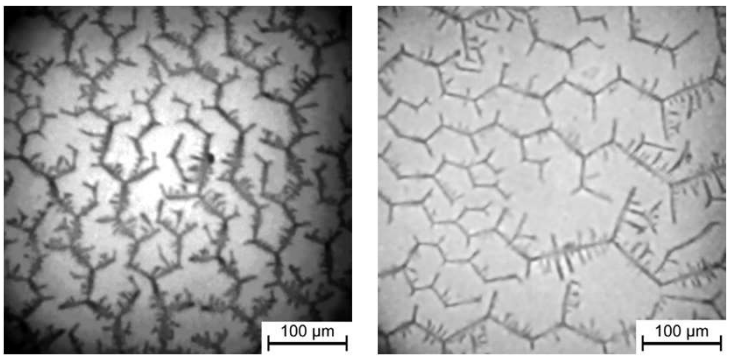

Fig. 1. Example micrographs for films obtained from 0.5 mg/ml BSA + 20 mmol/l NaCl solutions.

Methods

Sample solutions were prepared in distilled water, using 20 mmol/l NaCl, 0.5 mg/ml BSA (DiaM, USA), and a series of concentrations (from 0.1 to 0.4 mmol/l) of $AlCl_3$ or $FeCl_3$. The films were obtained by drying 0.5 ml of each sample in 20×20 mm^2 glass cells, in a low-pressure thermostatic environment. pH measurements were carried out using the pH-150MI pH meter (Izmeritelnaya Tekhnika, Moscow).

Results

Analysis of the influence of different concentrations of $AlCl_3$ and $FeCl_3$ on the change in texture parameters has shown that in the pH range from 3.58 to 3.38, the decrease in N_{segm} and L_{spec} for $AlCl_3$ ranges from 5000 to 1800 and from 4.2 to 2.6, respectively. Fig. 2 demonstrates typical textures for the films with 0.3 mmol/l $AlCl_3$.

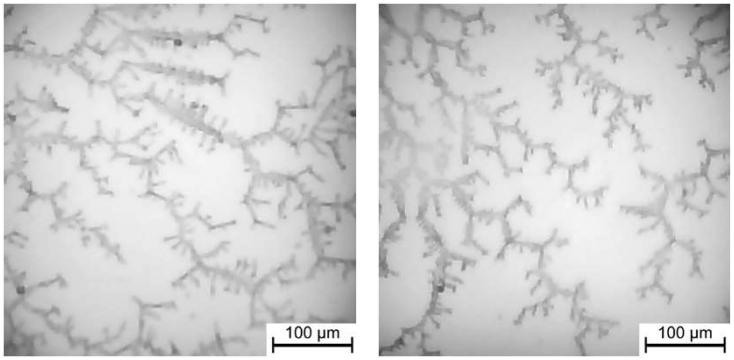

Fig. 2. Example micrographs for films obtained from 0.5 mg/ml BSA + 20 mmol/l NaCl + 0.3 mmol/l $AlCl_3$ solutions (pH ≈ 3.43).

In the pH range from 2.8 to 2.46, the decrease in N_{segm} and L_{spec} for $FeCl_3$ is from 6400 to 0 and from 6 to 0, respectively. Fig. 3 demonstrates typical textures for the films with 0.3 mmol/l $FeCl_3$.

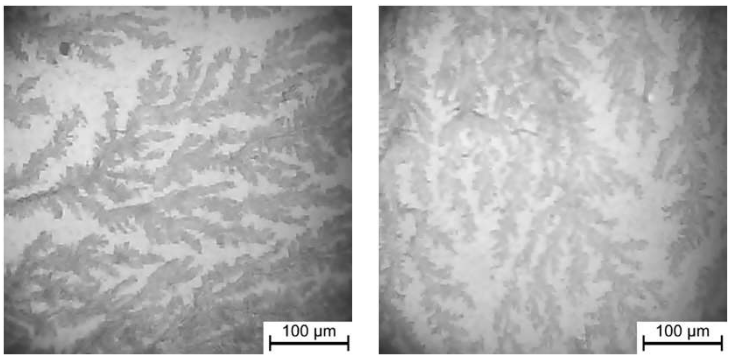

Fig. 3. Example micrographs for films obtained from 0.5 mg/ml BSA + 20 mmol/l NaCl + 0.3 mmol/l $FeCl_3$ solutions (pH ≈ 2.54).

The decrease in N_{segm} and L_{spec} correlates with the onset of BSA precipitation in solutions at pH < 3.7 ($AlCl_3$) and pH < 3 ($FeCl_3$), which may be due to the reentrant condensation in solutions due to a significant decrease in the absolute value of the protein surface potential [2].

Conclusion

Thus, it can be concluded that the dominant factor in the change in N_{segm} and L_{spec} is the change in the concentration of Al^{+3} and Fe^{+3} ions.

References

1. *Glibitskiy D. M., Gorobchenko O. A., Nikolov O. T., Cheipesh T. A., Dzhimieva T. N., Zaitseva I. S., Roshal A. D., Zibarov A. M., Shestopalova A. V., Semenov M. A., Glibitskiy G. M.* Method of estimation of the influence of chemical and physical factors on biopolymers by the textures of their films // Radiophys Electron.-2019.-**24**, N 1.-P. 58-68.

2. *Roosen-Runge F., Heck B. S., Zhang F., Kohlbacher O., Schreiber F.* Interplay of pH and Binding of Multivalent Metal Ions: Charge Inversion and Reentrant Condensation in Protein Solutions // J Phys Chem B.-2013.-**117**, N 18.-P. 5777–5787.

Contact information

Dmitriy Glibitskiy dima.glib@gmail.com