

INFLUENCE OF DISSOLVED GASES ON HIGHLY DILUTED AQUEOUS MEDIA

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The purpose of the report –

to show that the redox reactions involving dissolved gases change the physicochemical state of the aqueous medium and its sensitivity to various kinds of exposure.

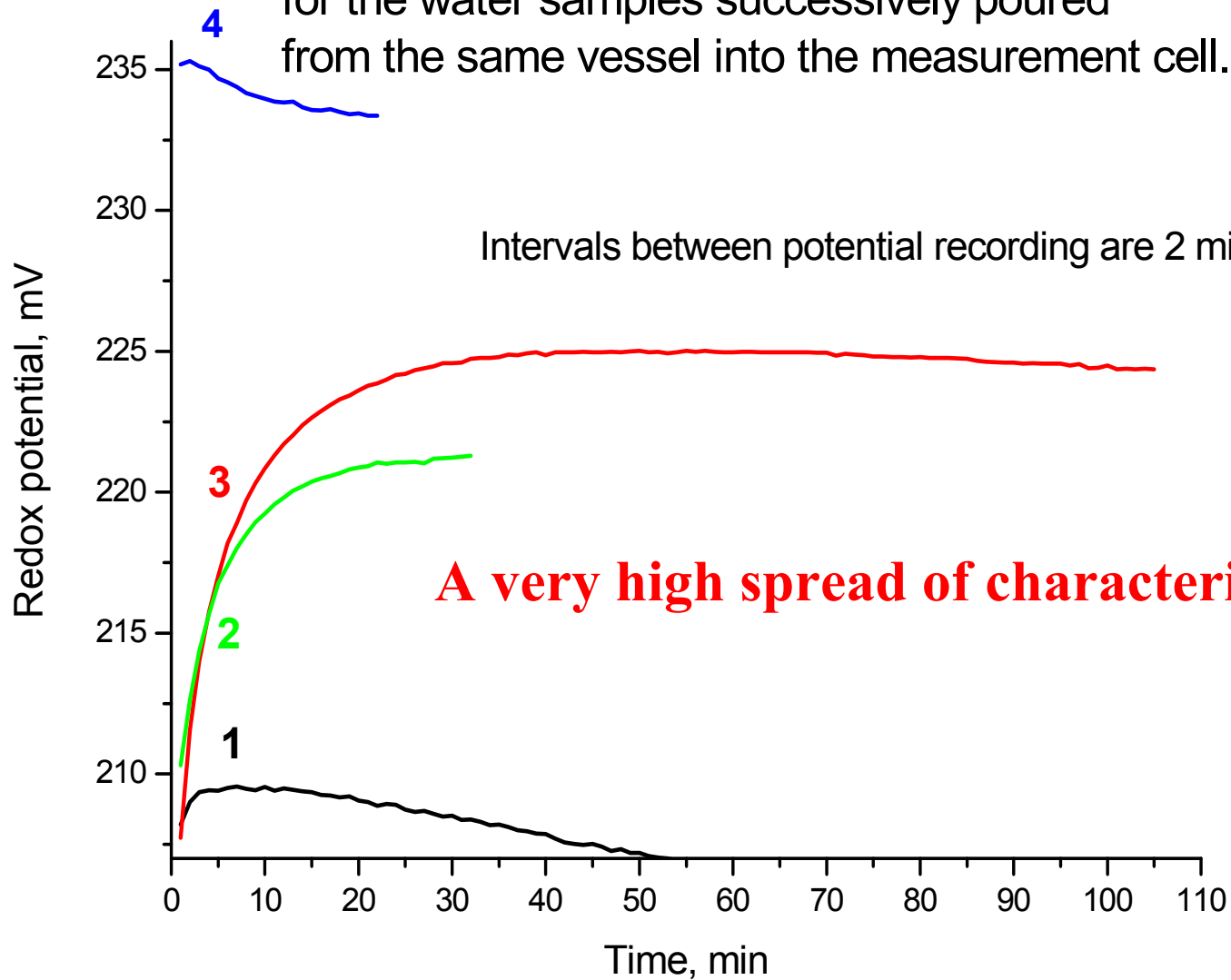
The water molecules and dissolved atmospheric gases can be excited and decay.

Products formed (the so-called reactive oxygen and water species - **ROS**) may enter into further reactions. They may be accumulated and affect the condition of the entire water system.

The results of two types of experiments:

1. **Redox potentials** are recorded for a series of identical samples of purified and presettled water exposed to ultraviolet radiation.
2. **Light scattering and ultraviolet fluorescence spectra** are obtained for purified water and highly diluted aqueous solutions with additions of substances that are able to affect the processes with the participation of reactive oxygen species (ROS).

Typical plots of potential recording in a measurement cell for the water samples successively poured from the same vessel into the measurement cell.



The experimental scheme

1. Standardization of purified water samples.

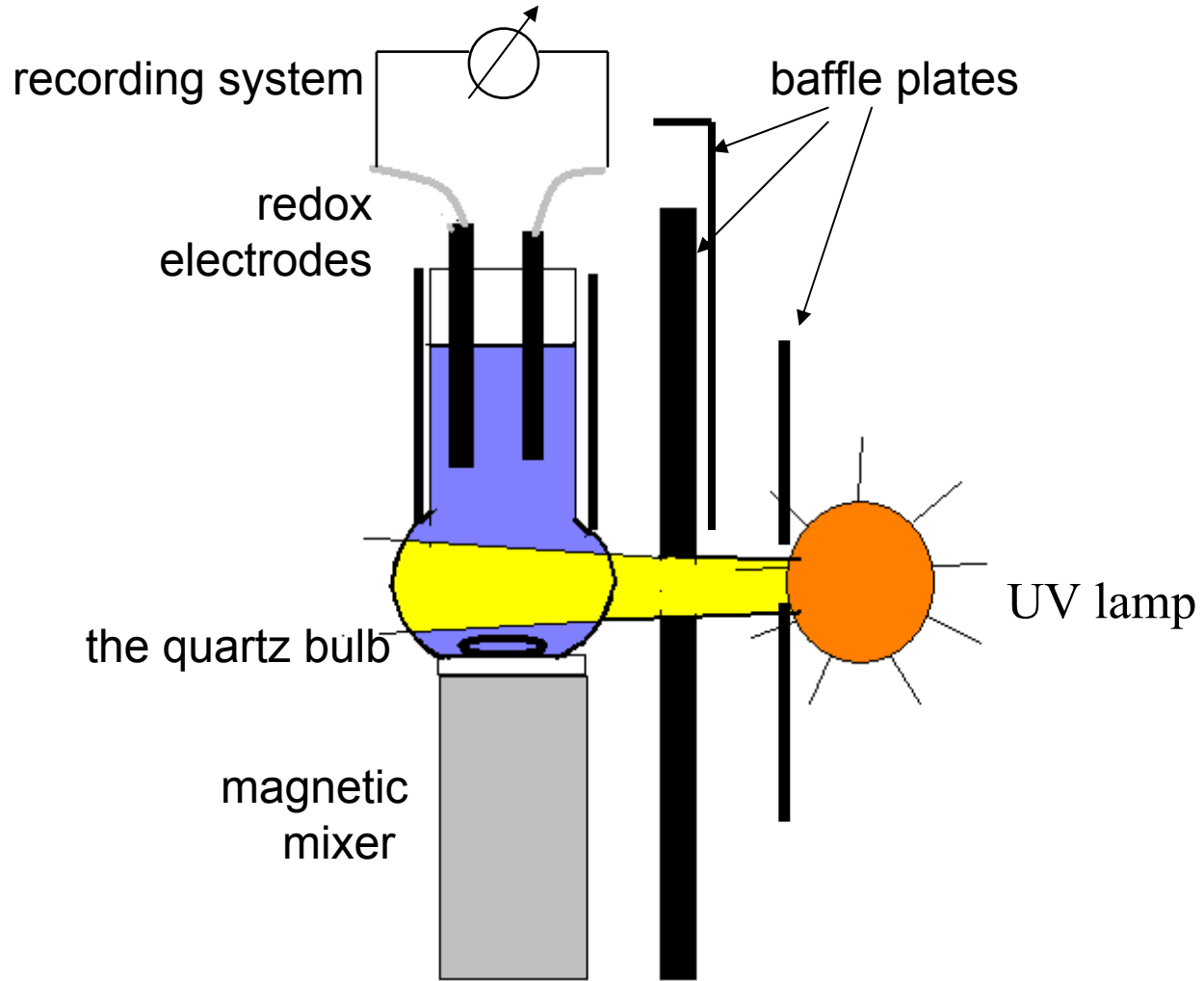
Water samples were poured into glasses (150ml each) and stored at room temperature **for two days**.

The sample to be tested was seven times transferred from the glass to the measuring quartz flask and back again.

All conditions, except the test beginning time, were maintained constant.

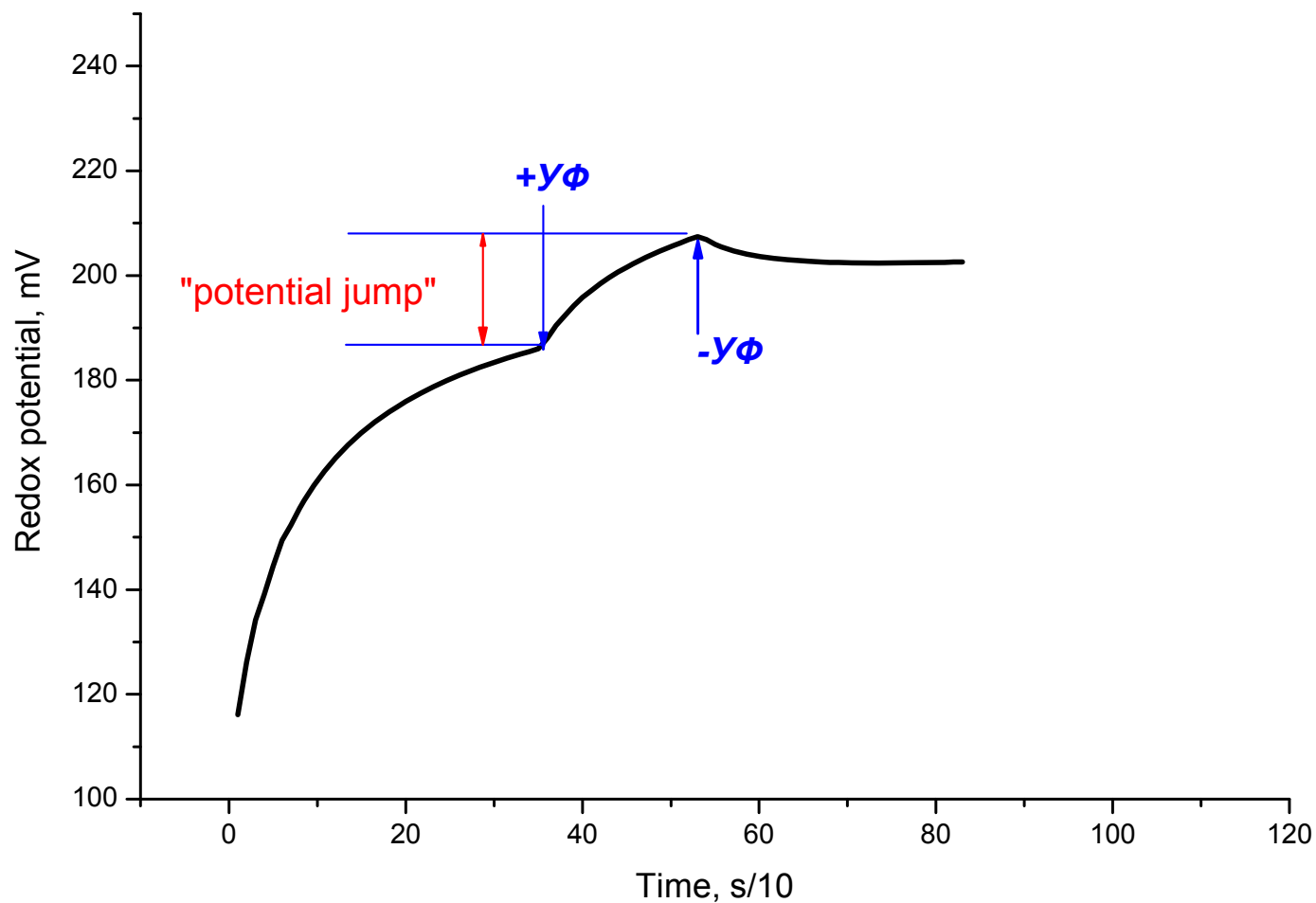
2. Kinetics of redox potential approach a plateau was recorded for each sample.
3. UV irradiation after reaching a plateau without interruption of the recording.

Installation scheme

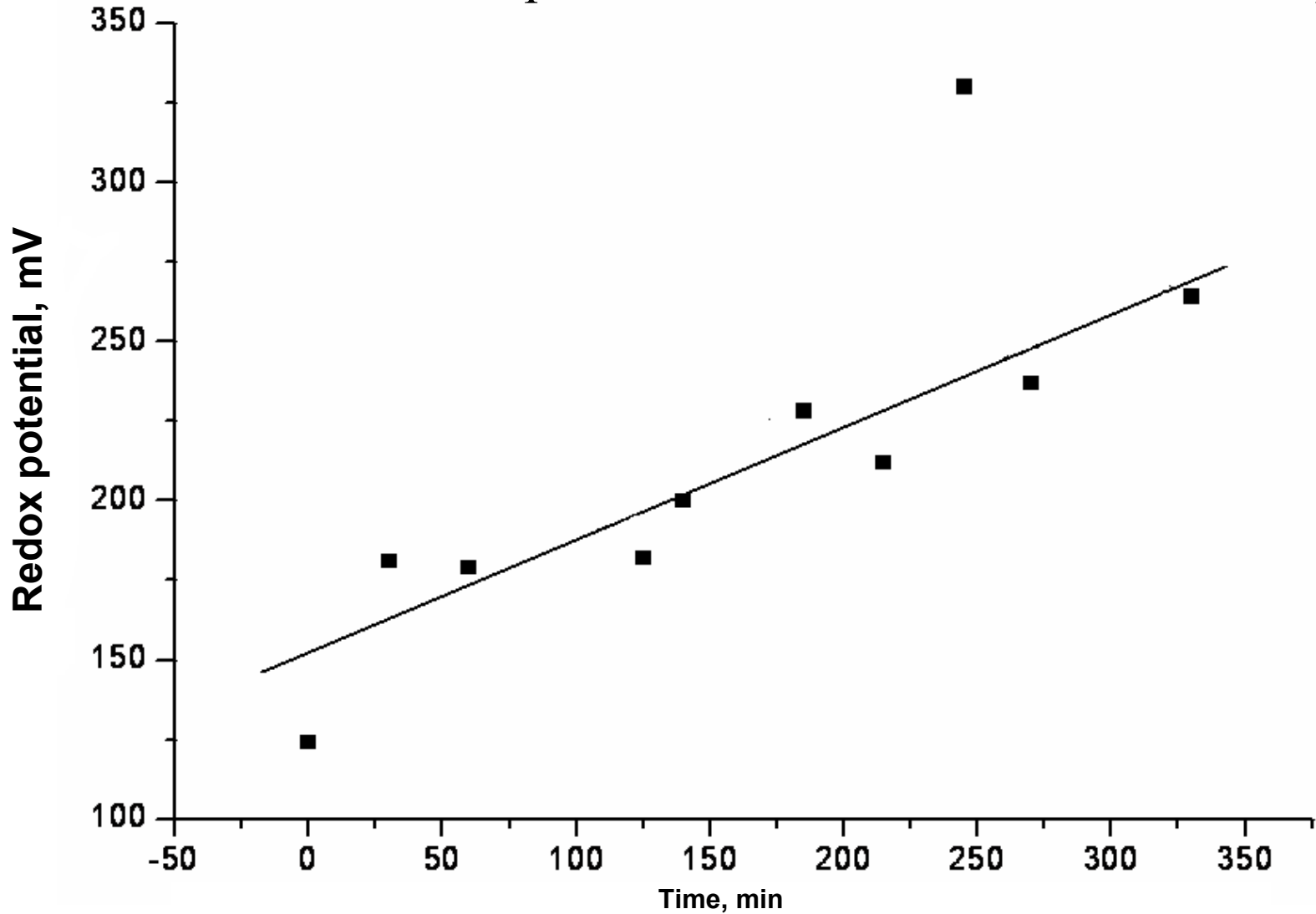


Dynamics of redox potential variation.

The blue arrows indicate the beginning (downward) and end (upward) of the UV-exposure.

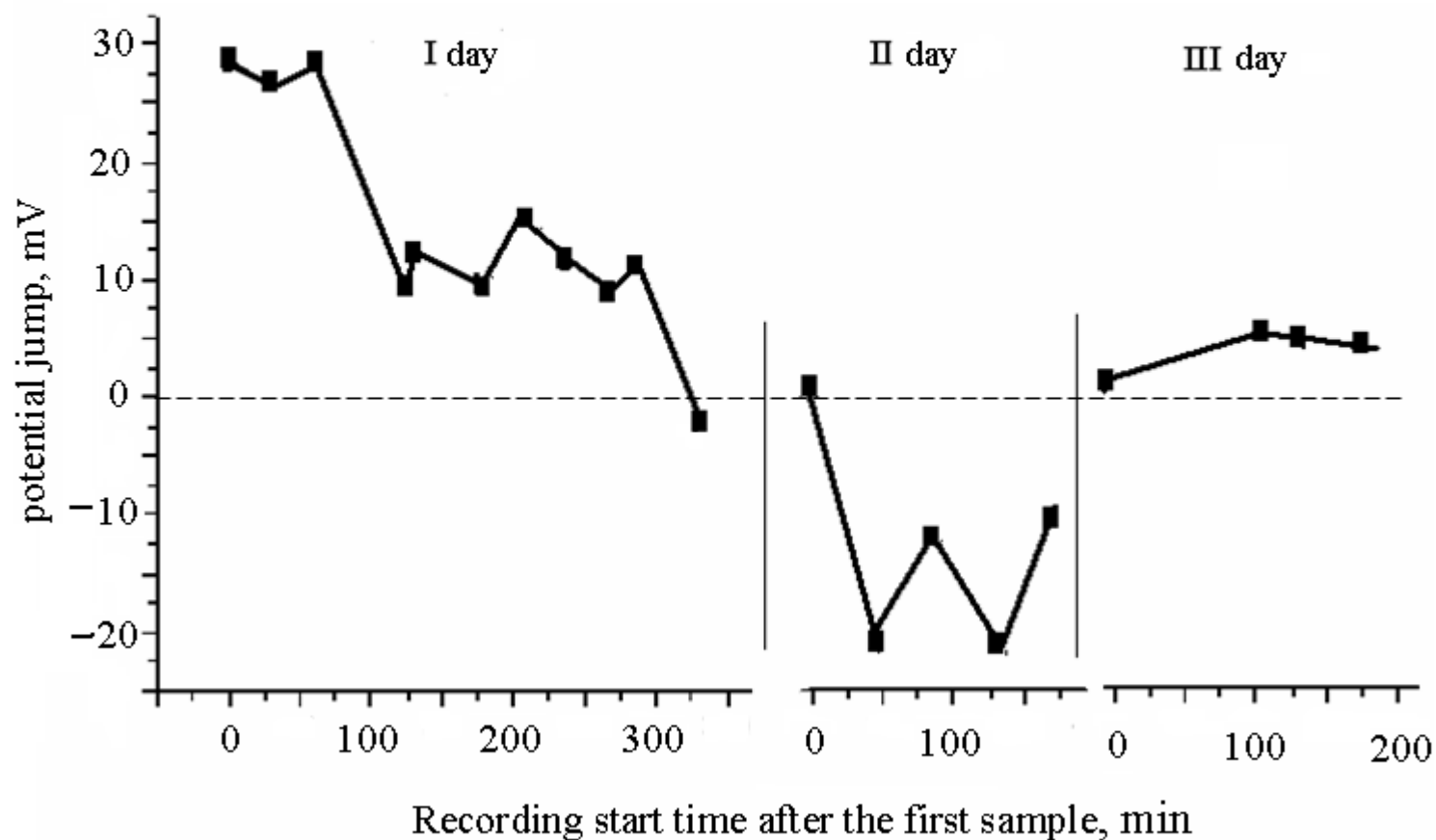


Plateau values of the potentials for the identical water samples.



The beginning time of the potential recording.

Three-day distributions of potential jumps



It was found out:

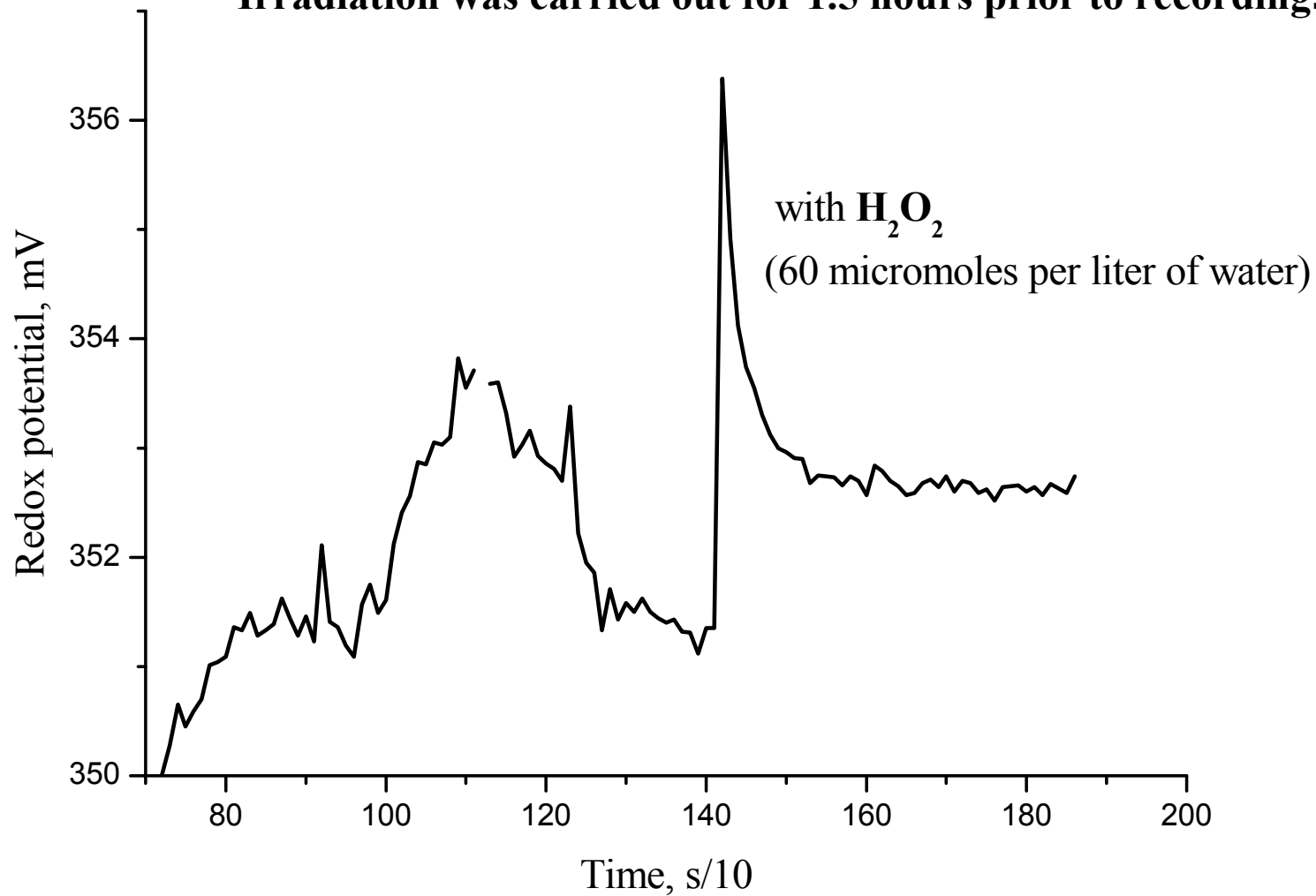
the variation in the potential during the exposure to the radiation and its relaxation after the termination of the exposure depended on the sample storage time.

The redox potential kinetics during the exposure noticeably changes both when the earlier tested samples were exposed again and when the exposure time was changed, which points to **the long-time variation in the state of the system after the exposure.**

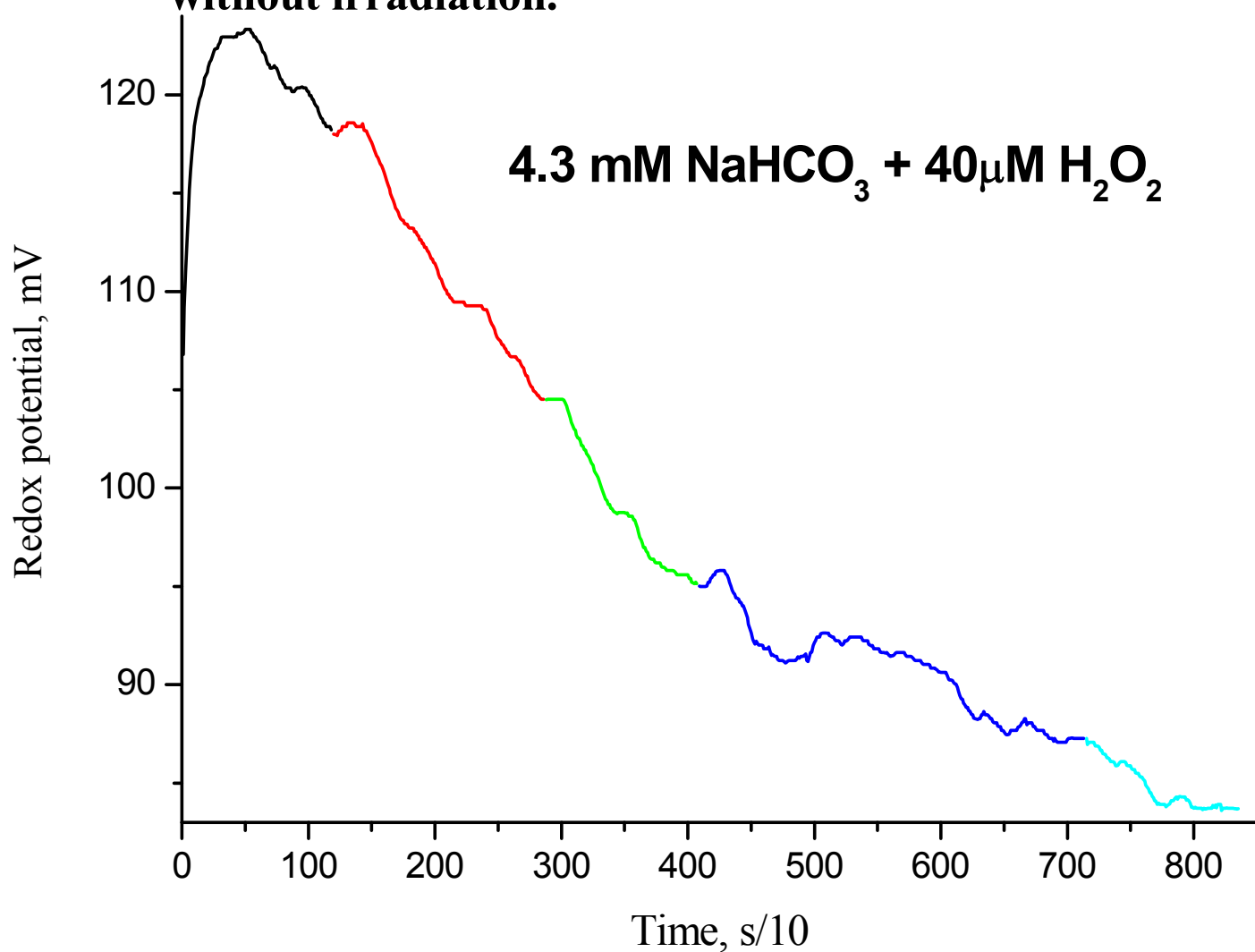
Small additions of various substances have a significant impact on the shape of the curve potency.

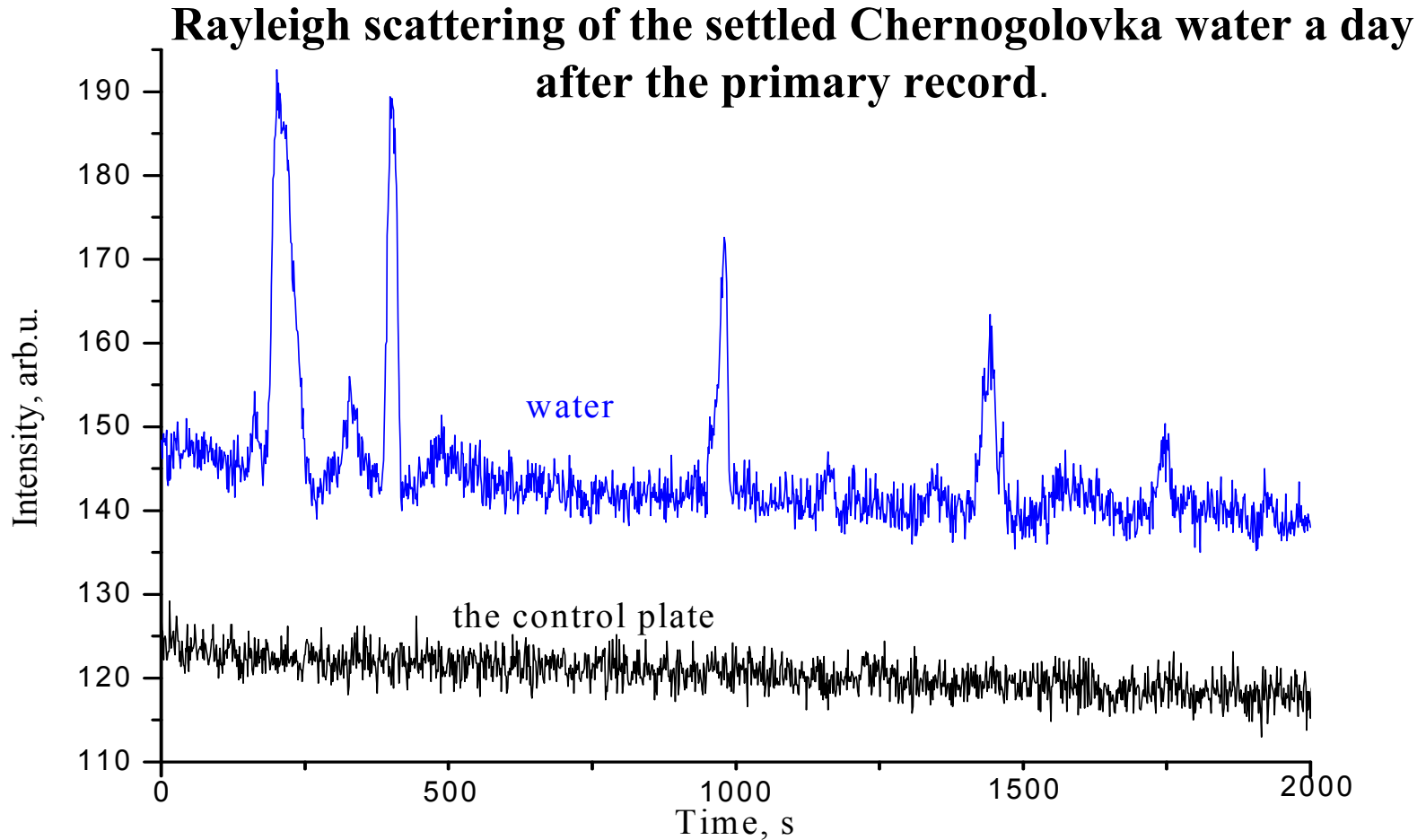
Additives substances capable of interacting with the ROS or having surface activity are strongly influenced.

**Kinetic of the redox potential after UV exposure.
Irradiation was carried out for 1.5 hours prior to recording.**



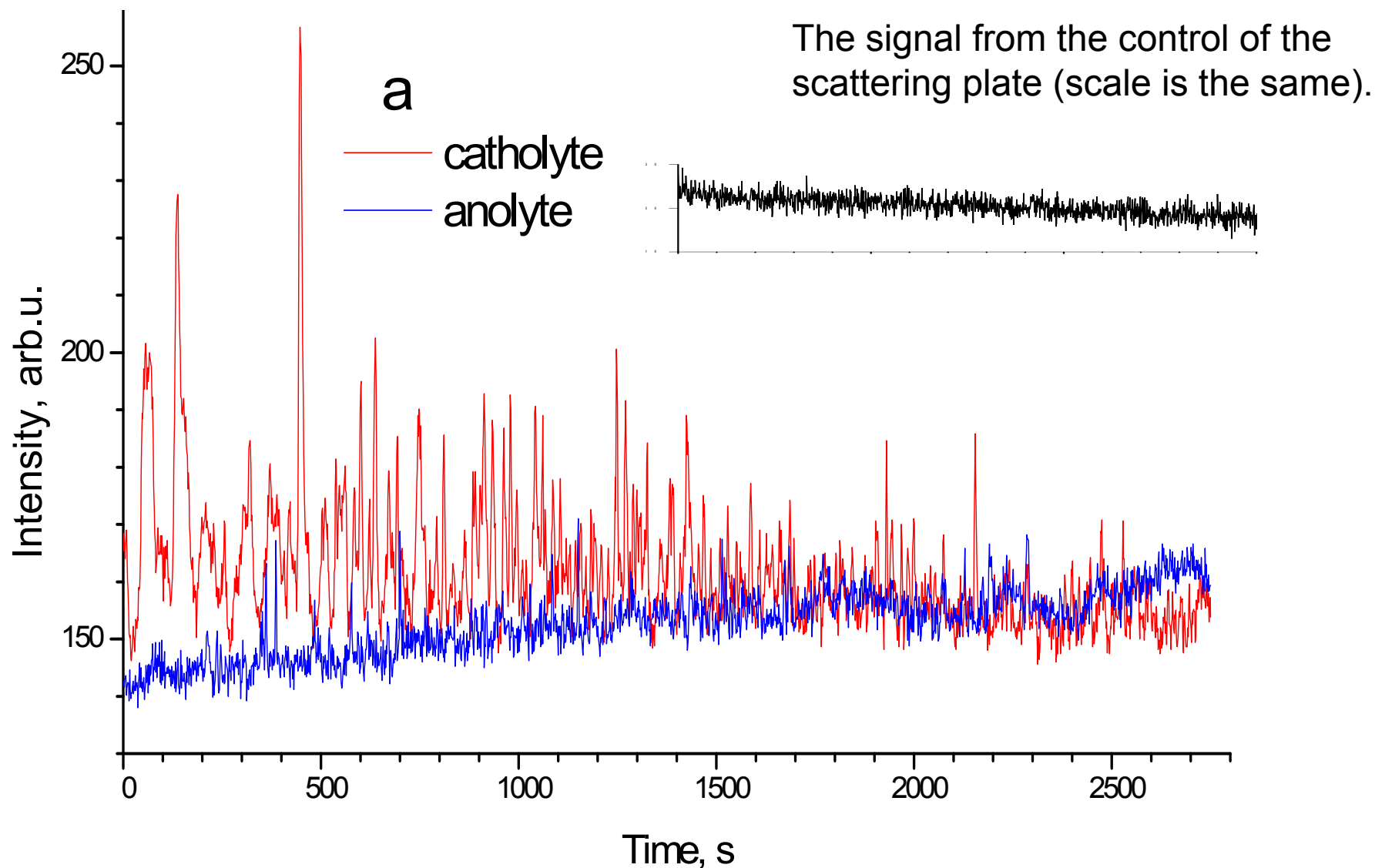
Kinetics of water with sodium bicarbonate and hydrogen peroxide without irradiation.



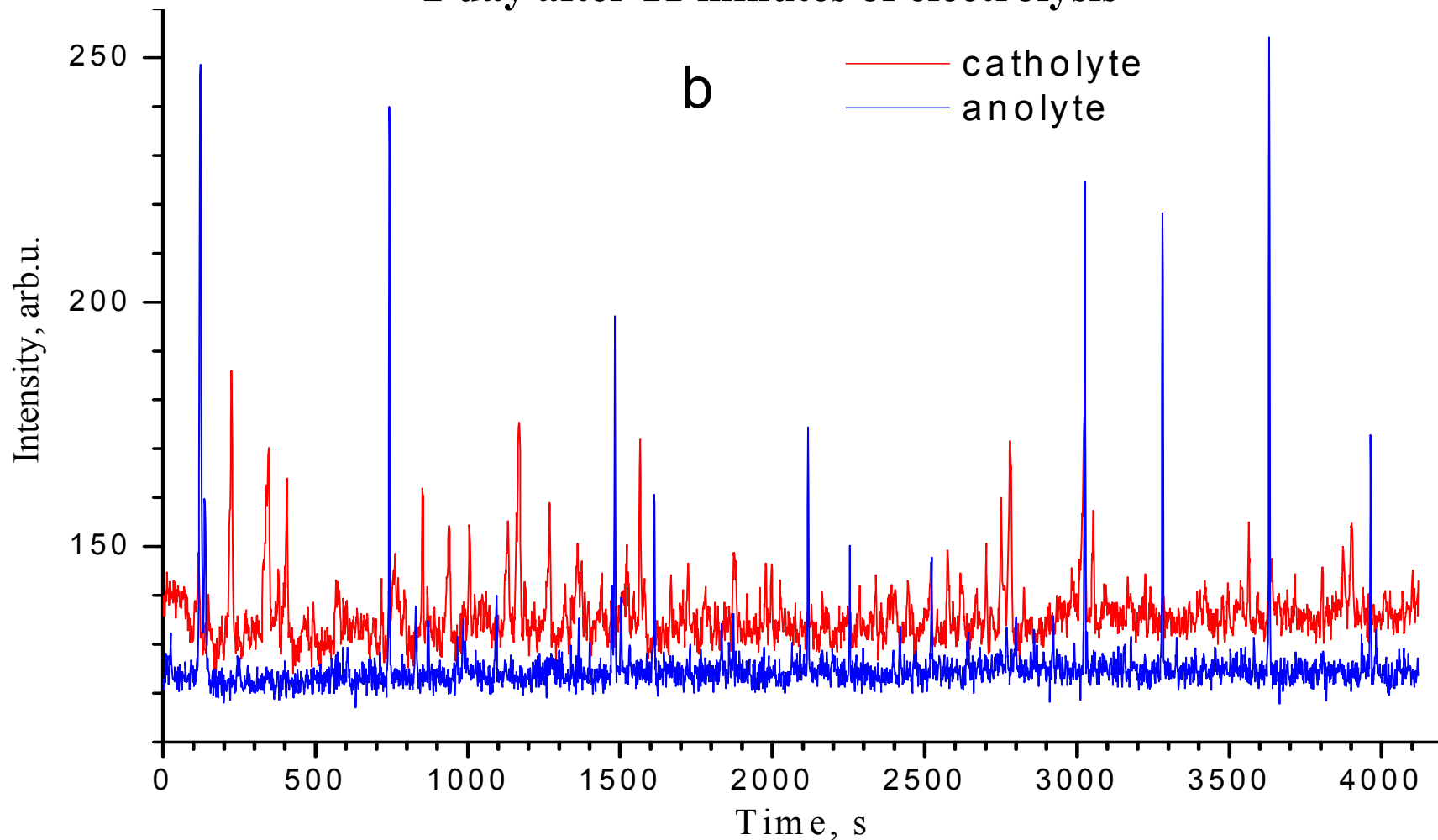


No initially noticeable oscillation of light scattering was revealed in this sample. The sample was stored in an open cell for a day and the kinetics recording was repeated. Chernogolovka water contains ions HCO_3^- (400mg l^{-1}), Ca^{2+} (130mg l^{-1}), and Mg^{2+} (65mg l^{-1}) with total salinity 1mg l^{-1} and total hardness $\leq 7\text{mg EQW l}^{-1}$.

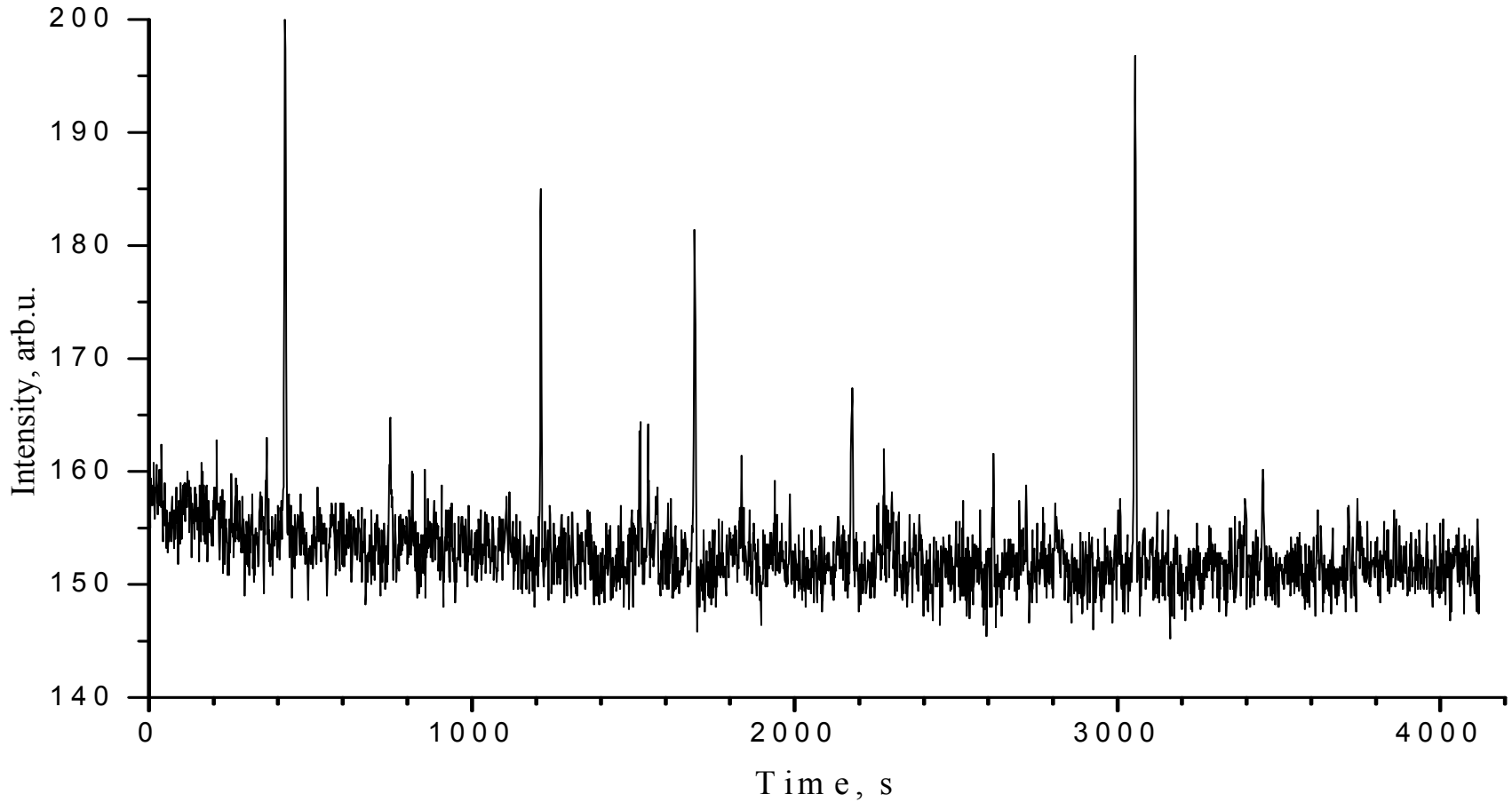
Rayleigh light scattering kinetics of Chernogolovka water ($\lambda_{\text{ex.}} = 260 \text{ nm}$) day after 11 minutes of electrolysis



**Rayleigh light scattering kinetics of Chernogolovka water ($\lambda_{\text{ex.}} = 260 \text{ nm}$)
2 day after 11 minutes of electrolysis**

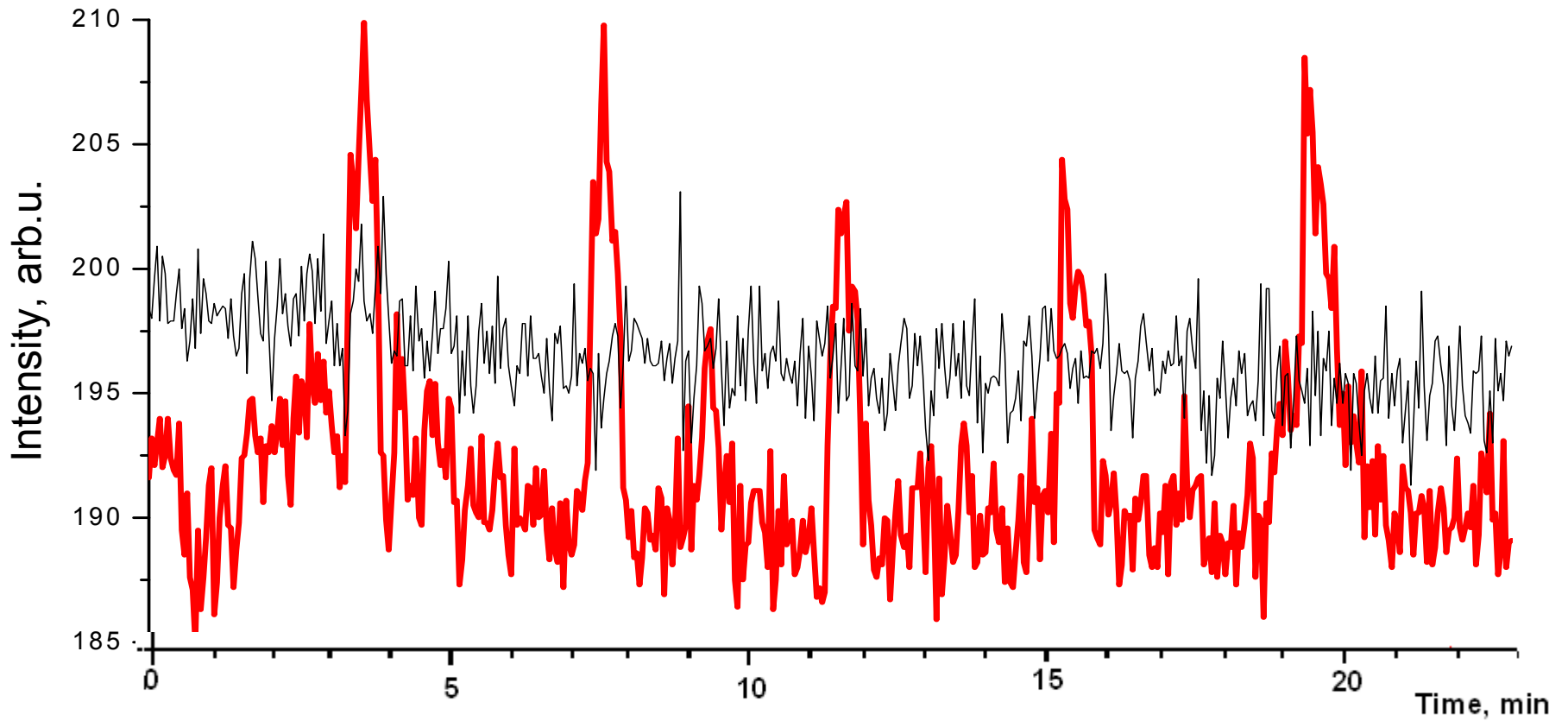


Rayleigh scattering ($\lambda_{ex} = 260$ nm) of the purified water stored for a week after the preparation.

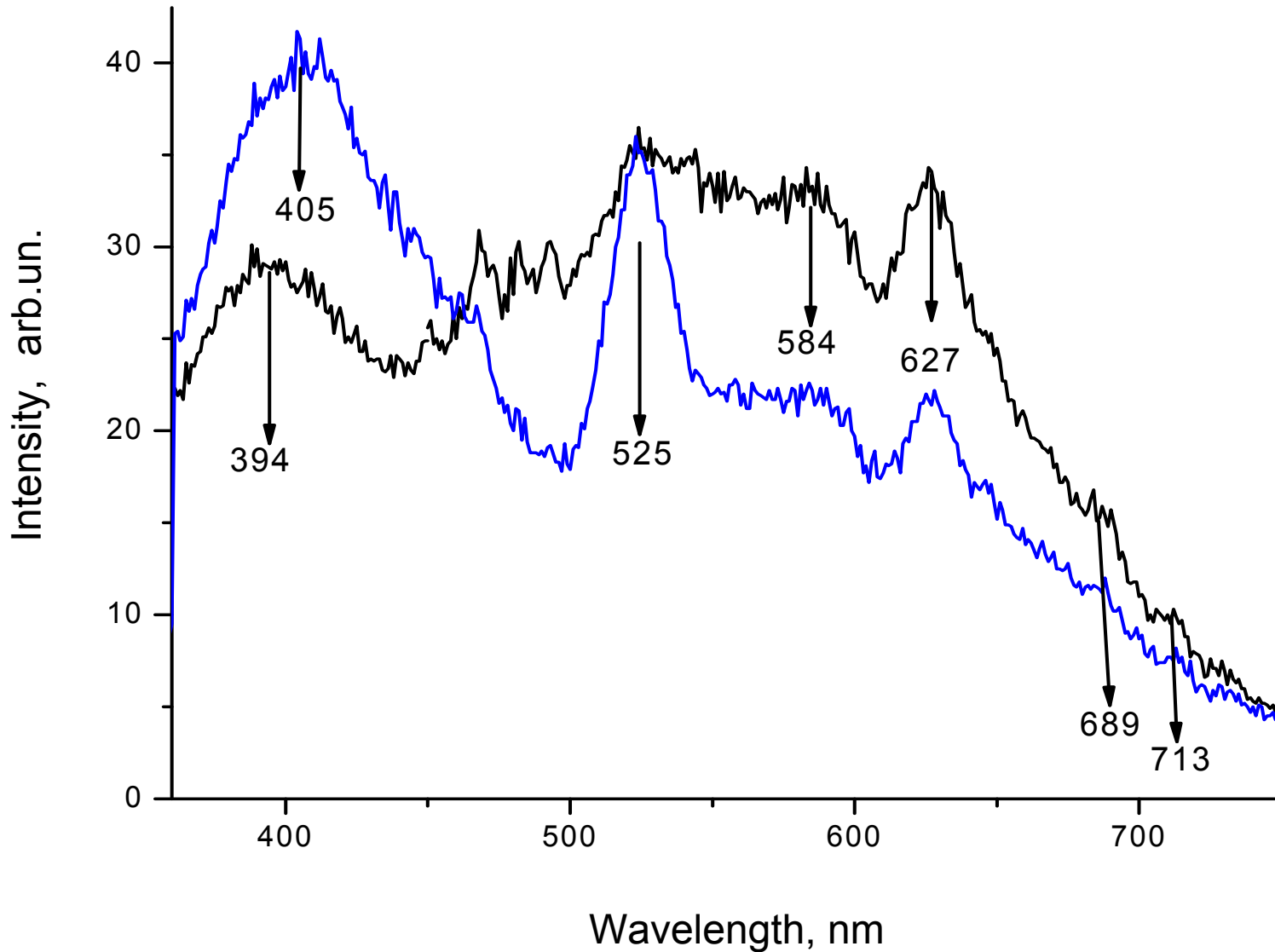


Rayleigh scattering ($\lambda_{ex} = 260 \text{ nm}$) of the purified water stored for a few weeks after the preparation (red).

The control plate - Black



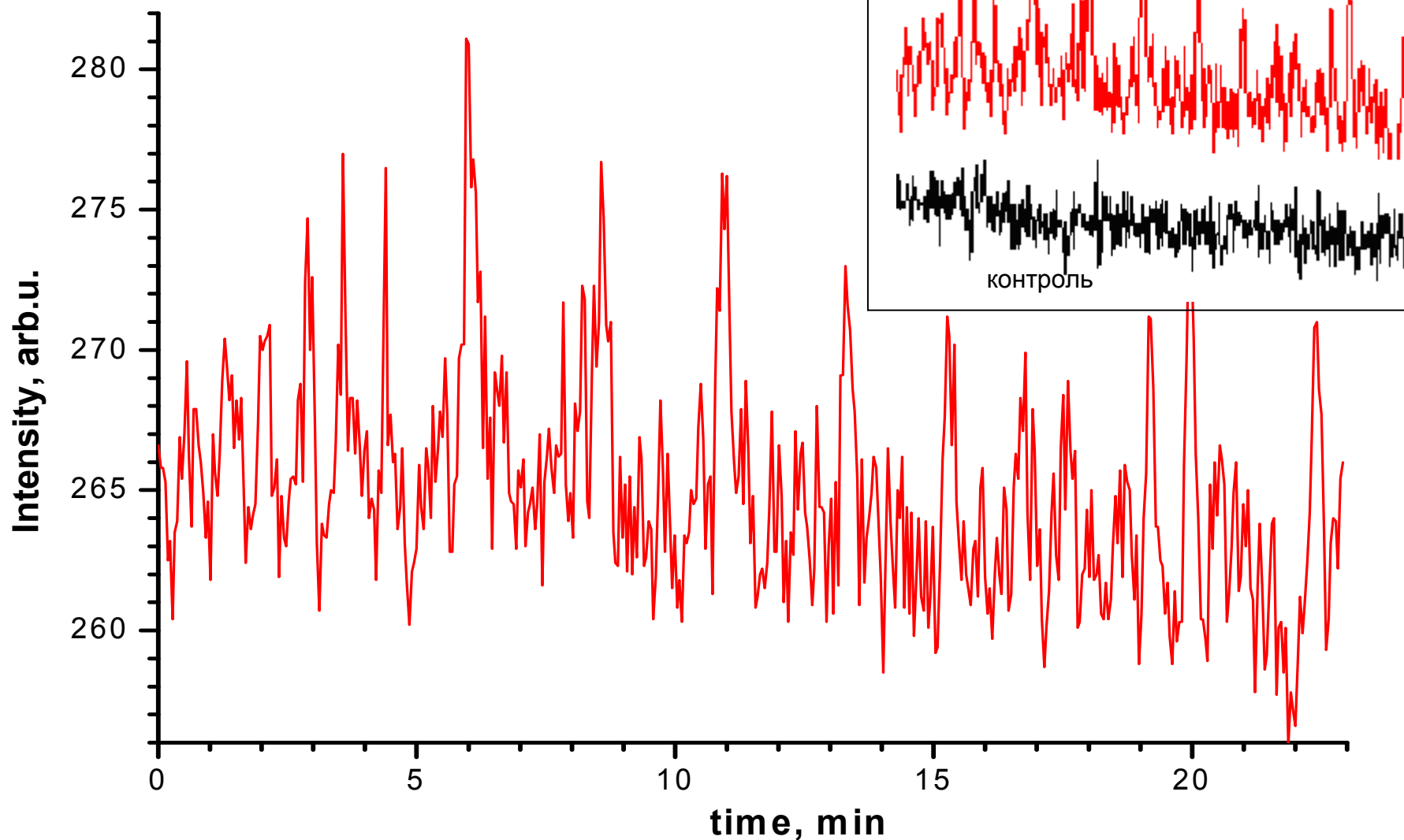
Typical bands of fluorescence spectra displayed in moments of sharp changes in the intensity of light scattering.



Rayleigh scattering ($\lambda_{ex} = 260$ nm) of the water sample, prepared by the "homeopathic" method.

5×10^{-9} % acetone in water (650 pM)

Insert - a comparison with the control on the same scale



Water homeopathic medicines are a source of vibration to which a living organism interacts.

The organization of water is carried out by processes involving ROS.

Water dissociation products (primarily H^+) may undergo redox transformations at the surface of the electrodes.

Their concentration is low in comparison with the concentrations of the undissociated water molecules and gases.

Concentration of molecules in liquid water under normal conditions

Molecule	H_2O	H^+, OH^-	H_2O_2	O_2	CO_2	HCO_3^-	N_2
Concentration, molecules/cm ³	$3 \cdot 10^{22}$	$1 \cdot 10^{14}$	$1 \cdot 10^{13}$	$1 \cdot 10^{17}$	$2 \cdot 10^{15}$ (pH 5,7-5,9)	$1 \cdot 10^{15}$	$3 \cdot 10^{17}$

For the hydrogen gas electrode, near which two protons are reduced to a hydrogen molecule via the reaction



the redox potential $E_{2\text{H}^+/\text{H}_2}$

is obtained using the Nernst equation for the two-electron transfer:

$$E_{2\text{H}^+/\text{H}_2} = E_{2\text{H}^+/\text{H}_2}^0 + \frac{0.059}{2} \cdot \lg \frac{a_{\text{H}^+}^2}{a_{\text{H}_2}}$$

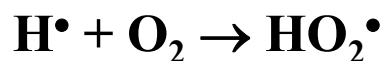
E_0 - standard redox potential of the system,

a_{H^+} and a_{H_2} - activities of protons and hydrogen molecules, respectively.

Reduction of the proton results to **hydrogen atom H^\bullet** with an unpaired electron. The gaseous hydrogen molecule **H_2** results from the reaction between two free radicals—hydrogen atoms:



It is highly probable that the hydrogen atom in water will interact with oxygen, which will give rise to the radical **HO_2^\bullet**



and



If the aqueous medium has neutral and alkaline pH, the radical decomposes **HO_2^\bullet** into a proton and a superoxide anion radical **$\text{O}_2^{\bullet-}$** :



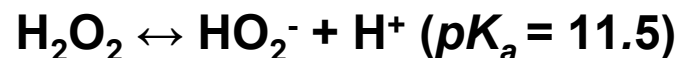
$\text{O}_2^{\bullet-}$ accumulated.

H^+ can enter into electron transfer reactions at the electrode surface again.

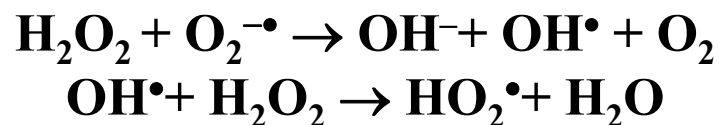
The concentration of **H_2O_2** and pH increase.

Redox potential decreases.

With pH higher than 11.5, peroxide decomposes, acidifying the medium



as hydrogen peroxide accumulates,
the $\text{O}_2^{\cdot-}$ contributes to its explosive decomposition.



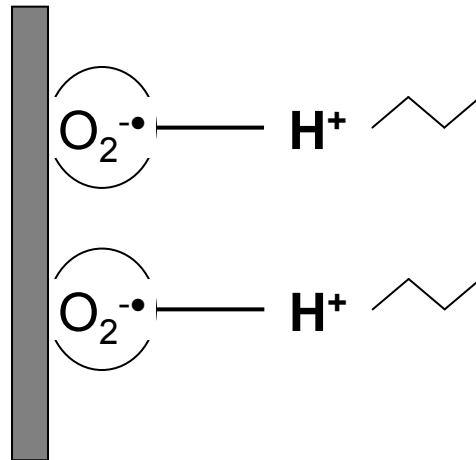
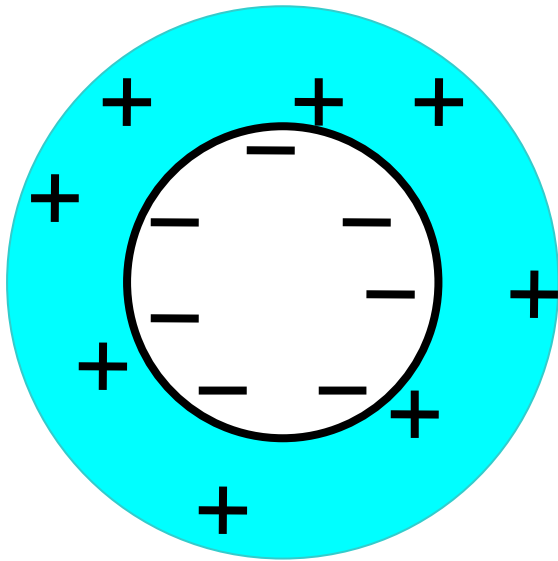
The hydroxyl radical can also result from absorption
of light by a hydrogen peroxide molecule:



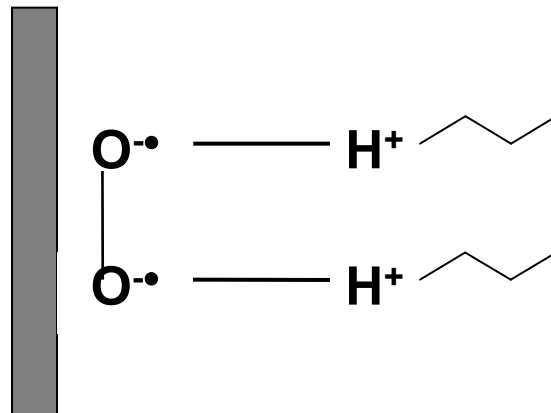
OH^\bullet - the strongest oxidant.

Redox potential of the water system increases.

Adsorption of superoxide anion radicals on surfaces gives rise to local electric and magnetic fields and favors a shift of the proton density in the surrounding system of hydrogen bonds of water. The water near the surface acquires special properties.

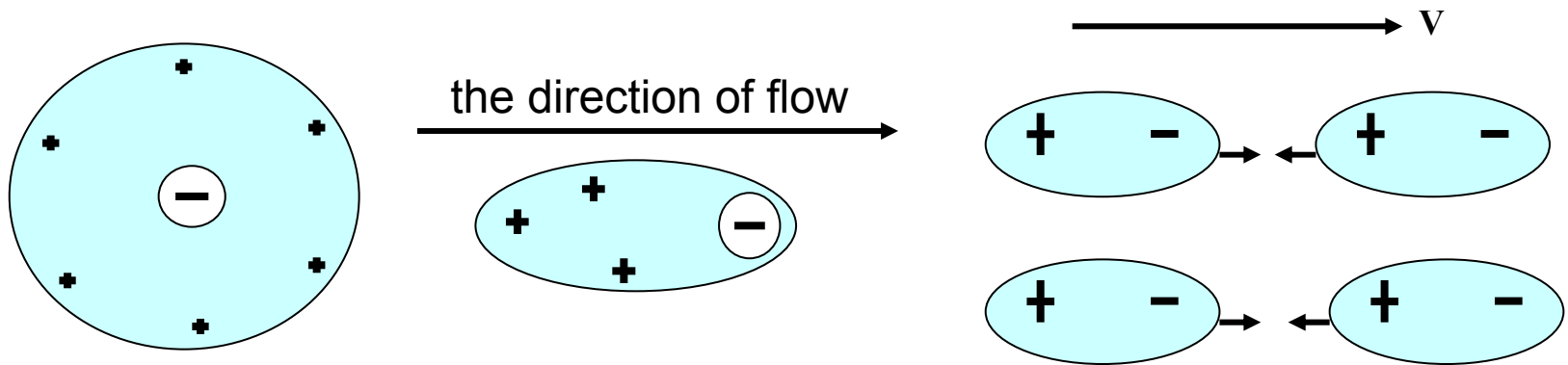


Adsorption of hydrogen peroxide



Interaction of the bubbles with different mobility nucleus and adjacent water shell

Upon mechanical exposure of water, centers of negative and positive charges move apart because of their different mobility, which results in dipole formations affecting the state of the protons nearest to them. The aqueous system becomes more and more unstable and sensitive to external perturbations and internal fluctuations.

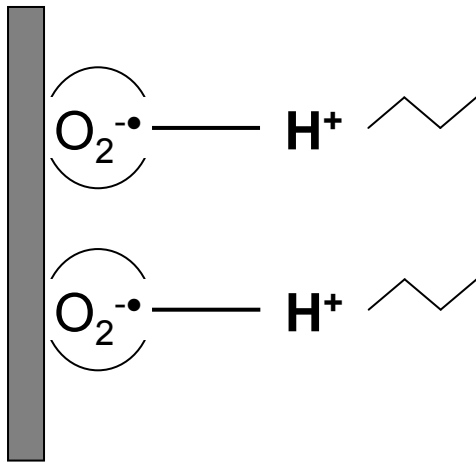


At particular critical values of the parameters of the dipole-dipole interaction the vibrations can become coherent in a considerable volume of the sample.

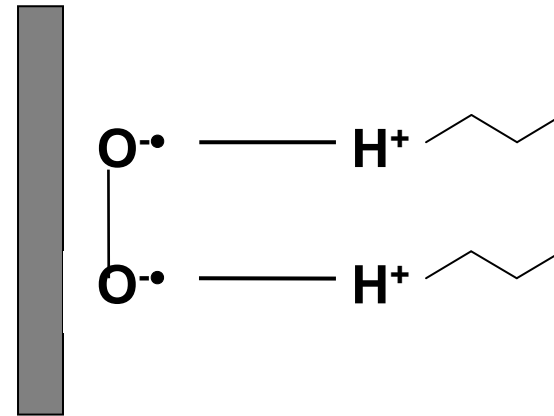
Vibrations of the ensemble of nuclear spins of protons around each vibrating bubble should be governed by variation in local electromagnetic fields and in turn affect dismutation of radicals at the surface.

It is probably this mechanism that is responsible for slow establishment of equilibrium after a change in the concentration of ortho and para water molecules

Adsorption of the radicals



Adsorption of hydrogen peroxide



When critical conditions are attained, H_2O_2 decay, the ordering of the system is violated and the accumulated energy is radiated.

Nitrogen oxides promote increase the redox potential.

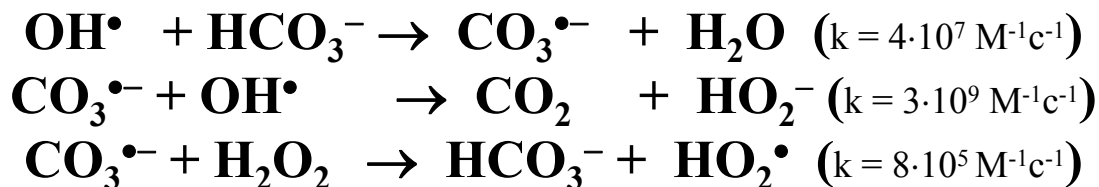
Hydroxyl radical promotes the formation of nitrogen oxides.

Due to nitrogen oxides, products with reduction tendency are eliminated while oxidizers accumulate in an avalanche-like manner.

The bicarbonate ions may reduce the redox potential.

The bicarbonate ion captures the hydroxyl radical, giving rise to a radical with reduction tendency.

For example, according to [*], there is the following system of processes:



[*] N. A. Aristova et al. "Mechanisms for Chemiluminescence in the Fenton Reaction,"
Preprint No. 2011-12/876, <http://dbserv.sinp.msu.ru:8080/sinp/files/pp-876.pdf>

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**Variations in the
Water Redox Potential under Ultraviolet Irradiation**

Physics of Wave Phenomena, 2013, Vol. 21, No. 3, pp. 183-189, 2013

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**Investigation of the Interaction of Dissolved Gasses with Water in Highly Diluted
Aqueous Media Using the Ultraviolet Fluorescence and Light Scattering Methods**

Physics of Wave Phenomena, 2013, Vol. 21, No. 3, pp. 190-200, 2013

The work is partly supported by the RFBR Projects 12-02-00970a and Federal Program "Research and scientific-pedagogical cadres Innovative Russia" in 2009-2013 years, Agreement #8689.

Thanks for your attention