Dependence of the spectral and luminescent properties of polymethylmethacrylate on its molecular weight

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The spectral and luminescent properties dependence of radiation-chemically synthesized polymethylmethacrylate on its molecular weight

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High-energy physics requires new luminescent materials with nanosecond flash times or less.

The study of luminescent structures based on porous aluminum oxide was carried out in works [1-3].

1 G.A.Lyubas, Metallized nanoporous anodic alumina films and their applications, J. Mater. Sci. 2018. V. 53. P. 15204.
2 G.A.Lyubas (2017) Generation of laser radiation by nanostructured solid active elements based on nanoporous aluminum oxide films activated with rhodamine 6G, Nanotechnologies in Russia 12:276–284.
3 G.A.Lyubas (2017) Generation of laser radiation by nanostructured solid active elements with selective optical nanoresonators formed in nanoporous aluminum oxide films, Nanosystems: Physics, Chemistry, Mathematics 8: 793–797.

The use of

polymethylmethacrylate

as a luminophore

has not been practically investigated.

This work is a logical continuation of the works [1-3].

The first aim of this study

The first aim of this study was to determine the effect of the molecular weight on the spectral characteristics of the radioluminescence of polymethylmethacrylate.

The second aim of this study

The second aim of this study was to determine the effect of the molecular weight on the properties of the diffractometry in hard synchrotron radiation of polymethylmethacrylate.

Synthesis

Polymethylmethacrylate was synthesized by synchrotron radiation of the VEPP-3 accelerator (Budker INP, flux density 6×10^{16} photons/$cm^2 \cdot s$, energy range 3-60 Kev).

Control

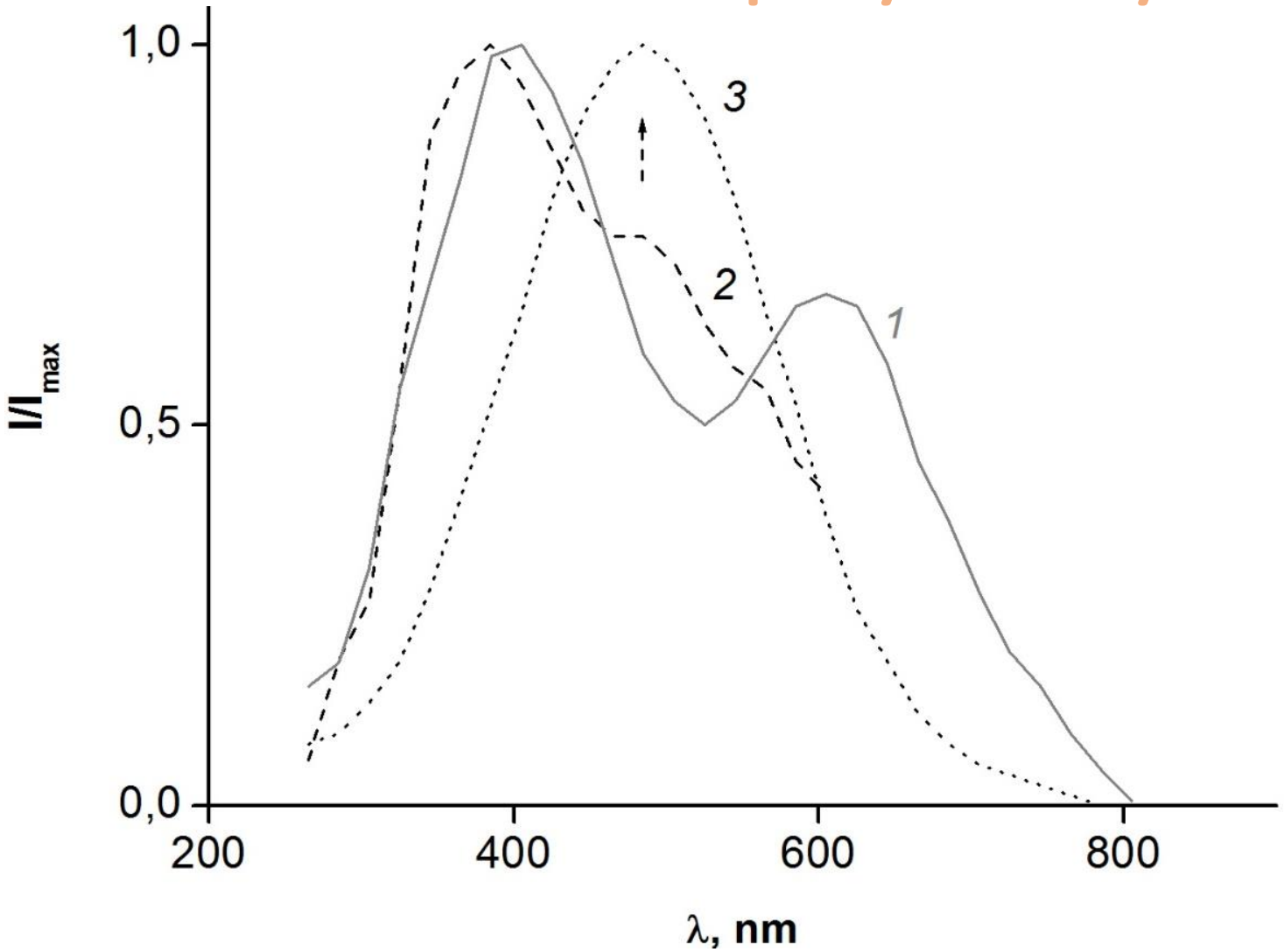
The control was carried out by recording luminescence spectra and their kinetics.

Study

To study the spectral and kinetic characteristics, X-ray spectroscopy with time resolution was used when a synchrotron radiation beam was excited at the experimental station "X-ray spectroscopy with time resolution" of Siberian Synchrotron and Terahertz Radiation Center (SSTRC), Budker INP, Novosibirsk.

X-ray spectroscopy with time resolution

Radioluminescent studies of polymethylmethacrylate

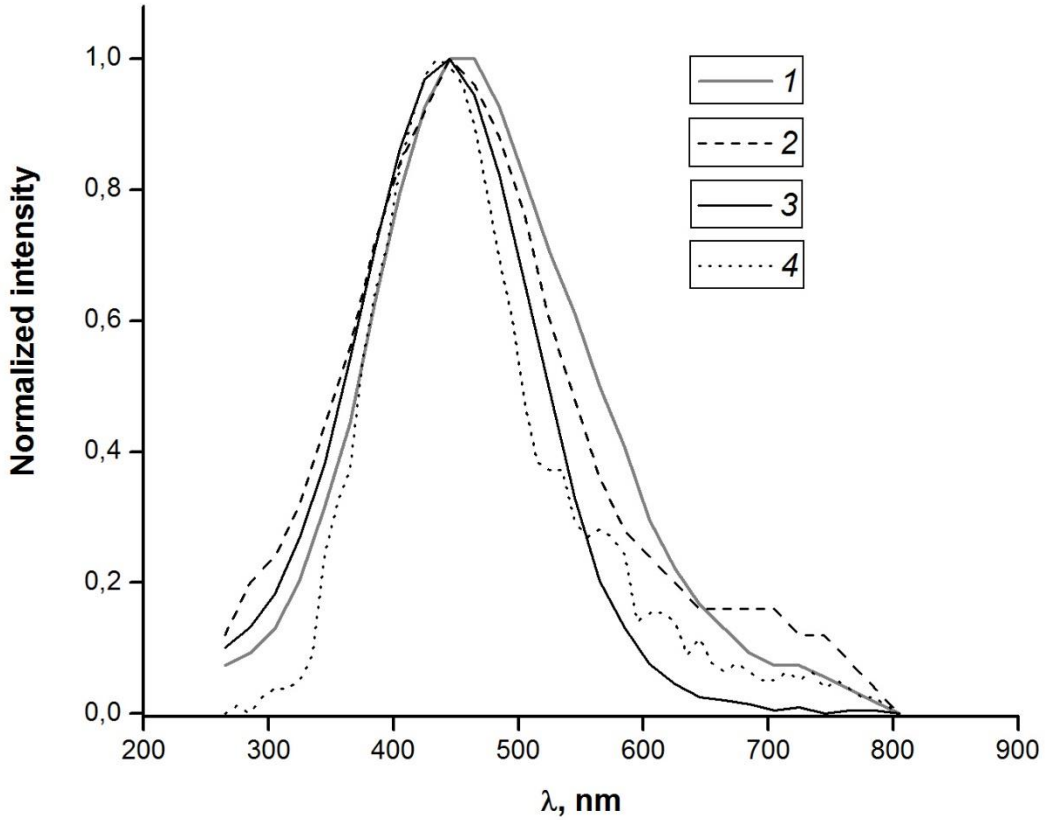


The luminescence spectra of the polymerization process. 1-initial MMA, 2 - at the time of polymer formation. 3-formed PMMA

It has been shown

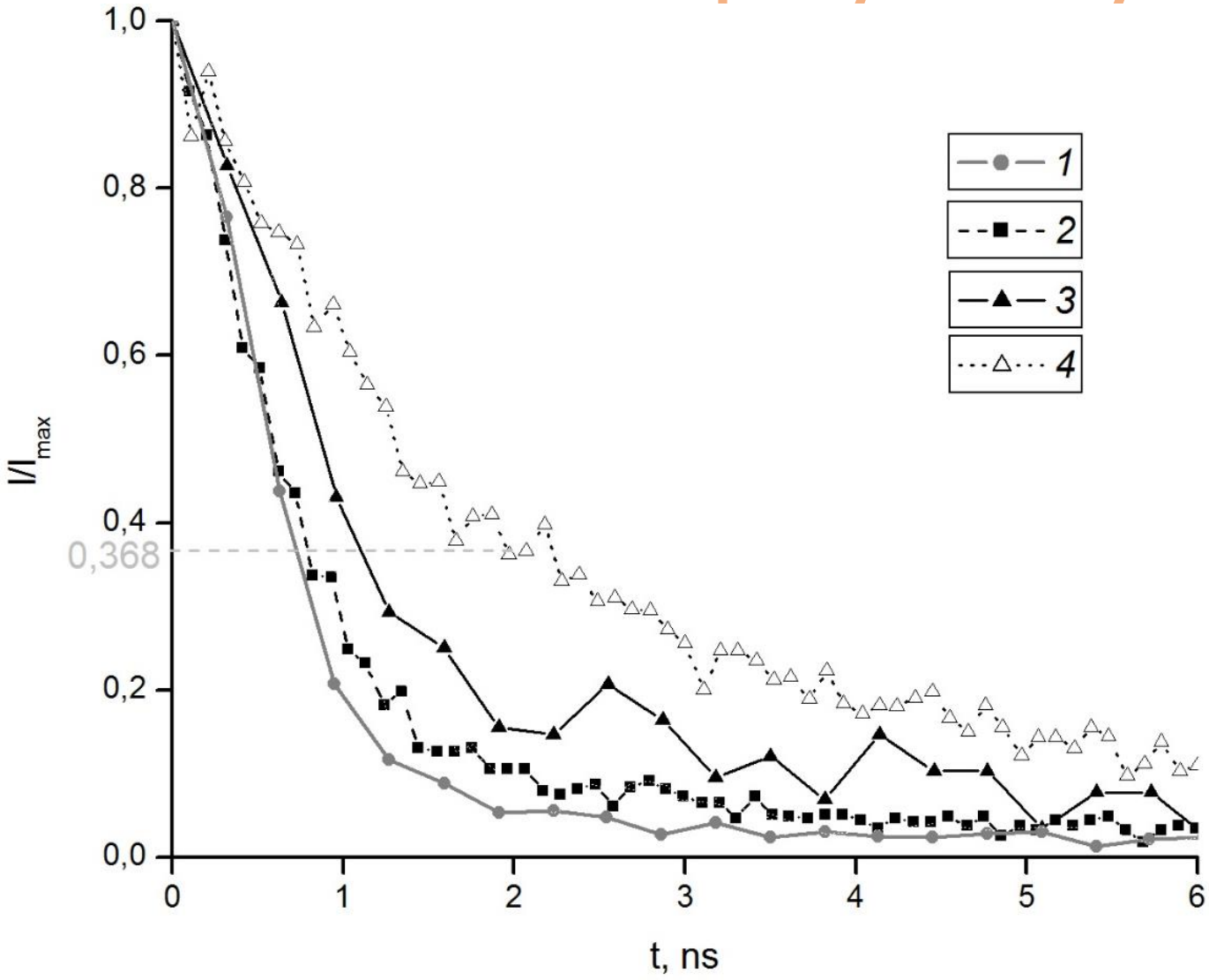
It has been shown that the maximum intensity of luminescence is registered at a wavelength of ~ 0.5 µm and that with increasing molecular weight, the decay time of luminescence decreases.

Radioluminescent studies of polymethylmethacrylate



<u>The luminescence spectra of PMMA with different molecular weight.</u> The samples are numbered according to table 1. It can be seen that as the molecular weight increases, the luminescence band width increases (see also table 1).

Radioluminescent studies of polymethylmethacrylate



<u>Spectra and kinetics of luminescence.</u> The samples are numbered according to table 1.

Radioluminescent studies of polymethylmethacrylate

Table 1

Sample parameters and results.

Sample number	Type	Molecular weight	τ, ns	$\Delta\lambda_{FWHM}$, nm
1	PMMA	~$6.5 \cdot 10^6$	0.7	196
2	PMMA	~$5 \cdot 10^6$	0.8	187
3	PMMA	~$3 \cdot 10^6$	1.1	164
4	PMMA	~$0.3 \cdot 10^6$	2.0	133

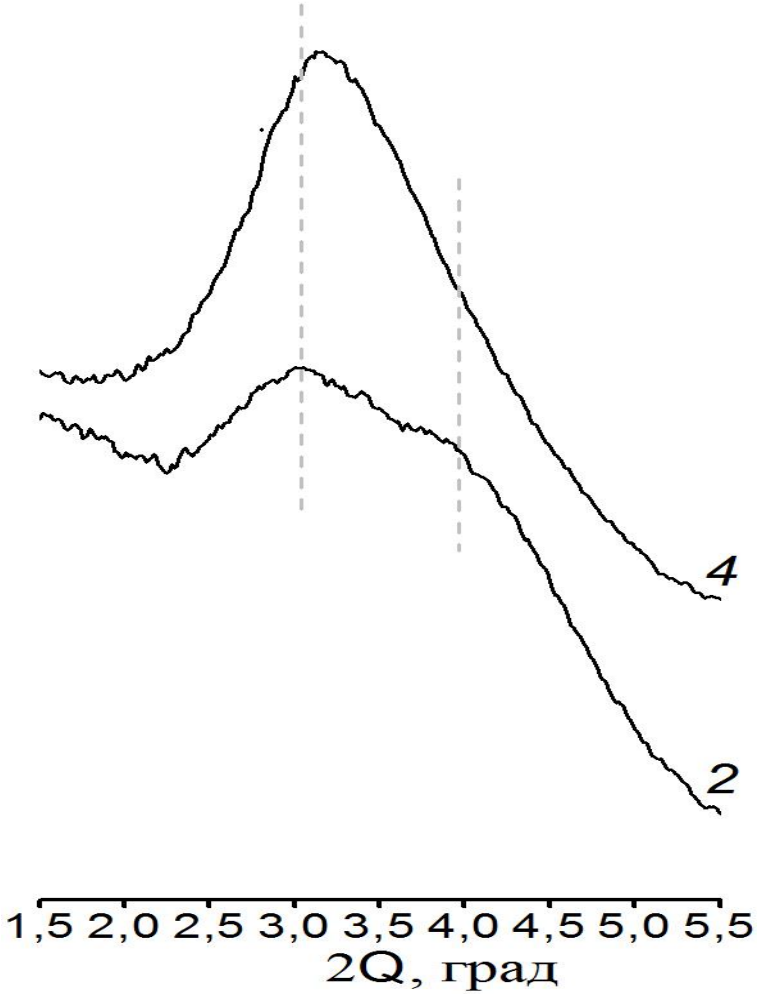
Note. 1. τ – is the luminescence decay time, $\Delta\lambda_{FWHM}$ – is the half-width of the luminescence band. The error is ± 0.1 ns.

The diffractometry in hard synchrotron radiation

According to diffraction data

According to diffraction data, high-molecular polymethylmethacrylate has a long-range order, when instead of one reflex with one maximum, two appear.

X-ray diffraction studies of polymethylmethacrylate



Diffractograms of supermolecular PMMA (2) and low-molecular PMMA (4)

According to diffraction data

The presence of an additional maximum near the main peak indicates that there was a change in the internal ordering of the structure of the polymer under study.

According to diffraction data

Diffraction data were obtained at the experimental station "Diffractometry in hard synchrotron radiation" of SSTRC, Budker INP, Novosibirsk.

The work was carried out within the framework of the state task (project AAAAAA-A17-117030310280-6) and the Siberian Synchrotron and Terahertz Radiation Center (SSTRC), Budker INP, Novosibirsk.

Thank you very much!