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GENERATION OF POWERFUL RADIATION WITH VARIABLE SPECTRUM IN THE 280 - 385 nm RANGE

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Submitted 28 November 1971
ZhETF Pis. Red. 15, No. 1, 26 - 30 (5 January 1972)

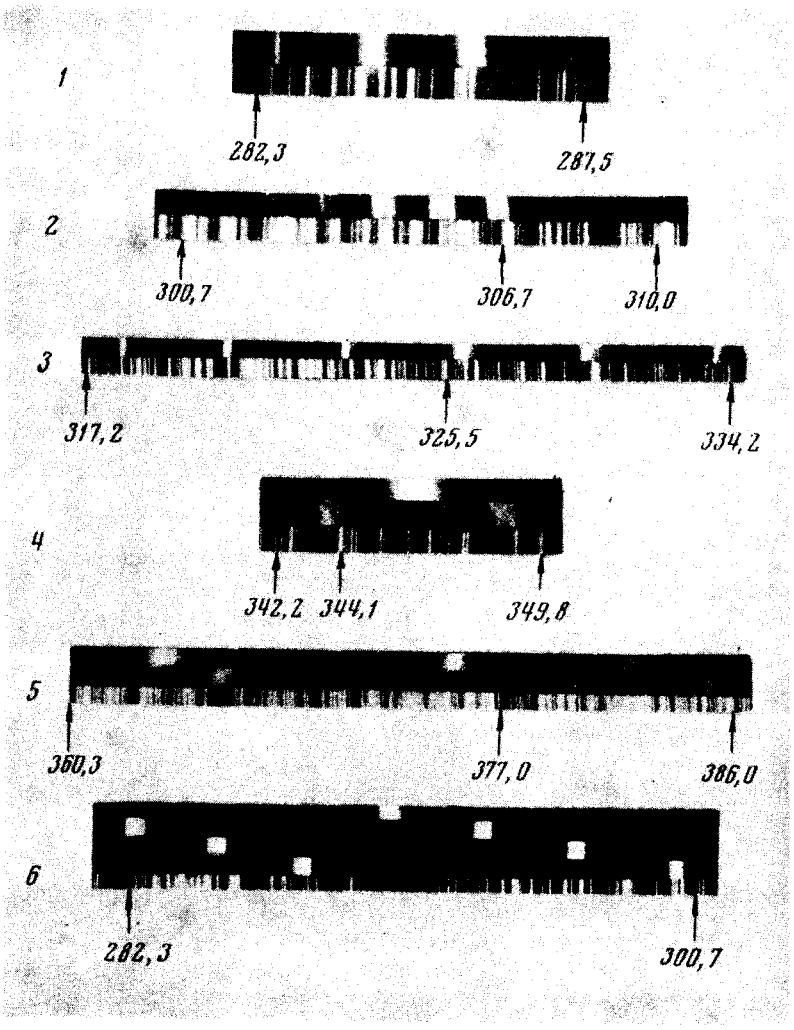
The use of lasers based on organic compounds has made it possible to obtain powerful laser radiation with the spectrum variable over the entire visible and near-infrared regions of the spectrum. Of particular importance is the extension of the range of such lasers into the ultraviolet region. Lasing of organic compounds down to 340 nm was attained in [1], and tunable lasing in the 330 - 352 nm range was obtained in [2]. To obtain shorter wavelengths, a more promising procedure is apparently to use dyes that generate in the visible region, with subsequent conversion into the second harmonic. This eliminates one of the main difficulties, in the need for finding organic media that are active at short wavelengths. Such a variant, furthermore, requires no resonator for the UV radiation and makes it possible to decrease the generation threshold, which for organic compounds is much lower in the visible region than in the ultraviolet. Conversion of the generation frequency of dyes with the aid of linear crystals was used to obtain tunable UV radiation in [3, 4]. In [3] the procedure used was to shift the emission frequency of a ruby or cryptocyanine-dye laser, and also double the cryptocyanine emission frequency. This made it possible to vary the spectrum in the 373 - 378 nm range. In [4] they obtained the second harmonic of a laser with rhodamine-6G, with tuning in the 290 - 300 nm range. The maximum radiation power attained in the latter case was only 40 W. We present here results of experiments wherein the laser spectrum was variable in the 280 - 385 range at a maximum radiation power 0.4 MW.

Table I

No.	Dyes	Dye lasing eff. %	Spectral region of dye lasing, nm	Phase matching angle	Spectral region of sec. harm. emission, nm
1	Rhodamine 6G	67.0	560,9 – 574,6	66° – 63°	280.0 – 287.3
2	№4546	35.0	603.4 – 617.8	60° – 58°	301.7 – 308.9
3	№3	23.4	635.2 – 668.4	56° – 53°	317.6 – 334.2
4	№26369	25.0	686.2 – 699.6	51°50′ – 51°	341.1 – 349.8
5	№4568	51.9	721.0 – 770.0	50° – 45°	360.5 – 385.0

The setup used to obtain tunable ultraviolet radiation was a neodymium laser Q-switched with a rotating prism. Its radiation was amplified by two quantum amplifiers. The output energy was 7.5 J at a lasing pulse duration of 50 nsec. The parallel beam from the laser was then incident on the KDP crystal 4 cm long and was converted into second-harmonic radiation by the oe → e method. The maximum energy conversion coefficient was 9.3%, with an average fundamental-radiation density in the crystal 150 MW/cm^2. Radiation with λ = 530 nm was used to pump a dye-based laser in accord with the "almost longitudinal" scheme. The dyes employed and the characteristics of their lasing are listed in Table I.

The second harmonic of a dye laser with beam divergence 6 - 7' was obtained with a KDP crystal (ℓ = 5 cm) by the oo → e method. The second-harmonic emission-line half-width was determined by the crystal dispersion and amounted to 2 - 3 Å. Thus, out of the entire dye generation spectrum of 14.6 nm width, only the part of the radiation in the spectral interval 4 - 6 Å was converted into the second harmonic. Rotation of the crystal, which changed the phase-synchronism angle from 66 to 45°, changed the frequency of the UV emission line from λ = 280 nm to λ = 385 nm (see Table I). The second-harmonic



Variation of second-harmonic spectra of different dyes (1 - 5 correspond to Table I, 6 - variation of second harmonic of rhodamine-6G laser with a dispersion prism inside the resonator).

Table II

λ, nm	Liquid laser eff. %	Liq. laser energy, J	Sec. harm. UV energy, J	η', % in energy	Emission power, MW
559,6	34.4	0.172	0.0036	2,1	0,180
565,0	43.0	0.215	0.0060	2.8	0,300
570,5	48,8	0.240	0,0074	3,1	0,370
574,0	51,0	0.255	0,0084	3,3	0,420
576,3	47,6	0,238	0,0072	3,0	0,360
582,0	36,7	0,1815	0,0042	2,3	0,210
588,5	29.5	0,1465	0,0028	1,3	0,140
595,0	28,1	0,1405	0,0026	1,8	0,130

Note: Neodymium-laser second-harmonic energy 0.5 J.
Liquid-laser emission duration ∿25 nsec.
Liquid-laser second-harmonic duration ∿20 nsec.

emission-spectrum variation of various dyes is illustrated by the spectrograms in the figure. The maximum efficiency of conversion into the second harmonic amounted to 0.53% in this case, the second-harmonic emission duration was ∿20 nsec, and the power was 0.09 MW.

To increase the UV radiation power, the spectrum of the liquid laser was decreased to 0.1 nm with the generation efficiency kept high by introducing a dispersion prism into the dye-laser resonator, in analogy with [5]. The characteristics of the lasing of rhodamine-6G and of its second harmonic, obtained in this case, are listed in Table II. The maximum dye generation efficiency occurred at λ = 574 nm and amounted to 51%, the energy efficiency of second-harmonic conversion (λ = 287 nm) was 3.3%, and the peak emission power at this wavelength was 0.42 MW.

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CONDUCTIVITY OF DOPED GERMANIUM AT INFRALOW TEMPERATURES

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Submitted 24 November 1971
ZhETF Pis. Red. 15, No. 1, 30 - 33 (5 January 1972)

As is well known, the conductivity of doped germanium at low (helium) temperatures is determined by the "impurity conduction" mechanism [1]. At low impurity concentrations this is the so-called "jump" conductivity, while at