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The Impact of Millimeter Waves on the Fluorescence of Aqueous Rhodamine 6G Solution

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This report presents the results of recording the non-thermal effect of millimeter waves on the fluorescence of an aqueous solution of rhodamine 6G. At low concentrations of dye molecules, normal temperature quenching of fluorescence is observed: its intensity decreases with increasing temperature. However, solutions with high dye concentrations show the opposite effect: with increasing temperature, the fluorescence intensity also increases. This is due to the temperature decomposition of dimers with low quantum yield into monomers with high quantum yield. We chose the optimal solution concentration at which these two effects are mutually compensated. In this case, the temperature coefficient is close to zero in the range of 20-30 C.
The effect of millimeter waves on the fluorescence of a solution of rhodamine 6g placed in a thin capillary inside a rectangular waveguide was studied. An infrared laser was used to heat the solution, the radiation of which, through a small hole in the wall of the waveguide, hit the specially blackened surface of the capillary. Blue laser light was passed through a hole in the opposite wall, exciting fluorescence. The fluorescence signal was recorded by a matrix spectrometer from the open end of the waveguide. It has been established that at a dye concentration close to the optimal one, reactions of the opposite sign are observed when exposed to an IR laser (thermal effect) and millimeter waves (non-thermal effect). In addition, the effects showed different dynamics: the impact of millimeter radiation was characterized by a significantly longer time constant compared to heating with an IR laser.
There are two possible mechanisms for the observed non-thermal effect: (1) a direct effect of millimeter waves on the activation energy, shifting the equilibrium towards monomers, and (2) an indirect effect on the reaction rate due to a change in the structure of water.

Topics

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