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Studies on the excited state characteristics of coumarin laser dyes

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The present work deals with the absorption and fluorescence studies of coumarin derivatives in different polar and non-polar organic solvents. Coumarin derivatives are hetrocyclic compounds with ring oxygen on a carbonyl group and most of them have a very efficient fluorescing ability. A large number of coumarin derivatives are used as laser dyes with a lasing wavelength in the spectral region from 440 nm to 540 nm. The photo-physical properties of these compounds depend on the nature and position of a substituent group in the parent molecule and also change due to a change in the surrounding media. Coumarin compounds are widely investigated due to their importance as laser dyes, as non-linear optical chromophores and as excellent probe to studying solvation dynamics in the homogeneous solutions as well as organized media. The absorption and fluorescence emission spectra of substituted coumarins namely 4-methyl-7-hydroxy coumarin (1); 4-methyl-7-dimethylamino coumarin (2); 4-methyl-7-amino coumarin (3); and 4-methyl-7-methoxy coumarin (4), were obtained in various polar and non-polar organic solvents of varying dipole moment. Using solvatochromic data numerous spectral parameters namely, excited state dipole moment; half bandwidth; extinction coefficient; radiative life time; relative quantum yield and percentage polarization of these compounds were calculated. The dipole moment in the excited state of all these molecules was investigated which is higher than their corresponding values in the ground state. Also, the value of excited state dipole moment depends on the nature and location of the substituent group. The increase in dipole moment upon excitation and the effect of substituent have been explained in terms of the resonance structures of the molecules as well as intra molecular charge transfer process. The values of measurements of polarization and quantum yield of fluorescence of these molecules depend on the nature of solvents. It was further observed that the polarization values obtained cannot be explained merely in terms of the viscosity effect. It was found necessary to consider the change in the lifetime of the excited molecule to account for polarization values. The results also indicate the formation of weakly bound solute-solvent complexes in polar solvents.

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