

The Syntheses and Application of NIR Dyes Based On Light Absorbing Properties

Soo-Youl Park, Seung-Rim Shin, Joung-II Shin, Kyoung-Lyong An, Sang-OH Lee, Kun Jun

Chemical Biotechnology Research Center, Korea Research Institute of Chemical Technology
P.O. BOX 107, Sinseongno 19, Yuseong, Daejeon 305-600, Korea
E-mail: sypark@kRICT.re.kr

1. ABSTRACT

The near-infrared absorbing donor-acceptor chromophores have been investigated by varying the electron donating and accepting molecular moiety. A series of near-infrared absorbing chromophores were offered narrow and intense absorption band in a various organic solvents. The dyes synthesised were, however, strongly bathochromic shift which extended well into the near-infrared region. The functional uses of dyes are vast in number, and it is convenient to classify them in some way. In all cases, it is the π -chromophore that plays a major role in the functional application. "Light absorption" is of course the most commonly used property of a dye chromophore, and it can be employed directly, e.g. in light filters and optical data recording, or it can be used to drive further functional processes, e.g. fluorescence, photochromism, photosensitization.

2. INTRODUCTION

Since Perkin's discovery of Mauvein in 1856 the research has been intensive and has many significant advance. In recent years, the focus moved away from the traditional areas of coloration of textiles into new high technology fields. The near-infrared absorbing dyes absorb light beyond 700 nm (Fig 1.). This is light absorbed by a dye is invisible to the human eye and so infrared dyes are undetectable to the observer. Such demands on a dye chromophore severely limits the π -electron structure of the molecule. Thus the energy gap between the highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO) must be very narrow (150KJmol^{-1} or less). At the same time other possible transitions HOMO-1 \rightarrow LUMO and HOMO \rightarrow LUMO-1 must be sufficient high in energy to avoid absorption of visible light (greater than 300KJmol^{-1})

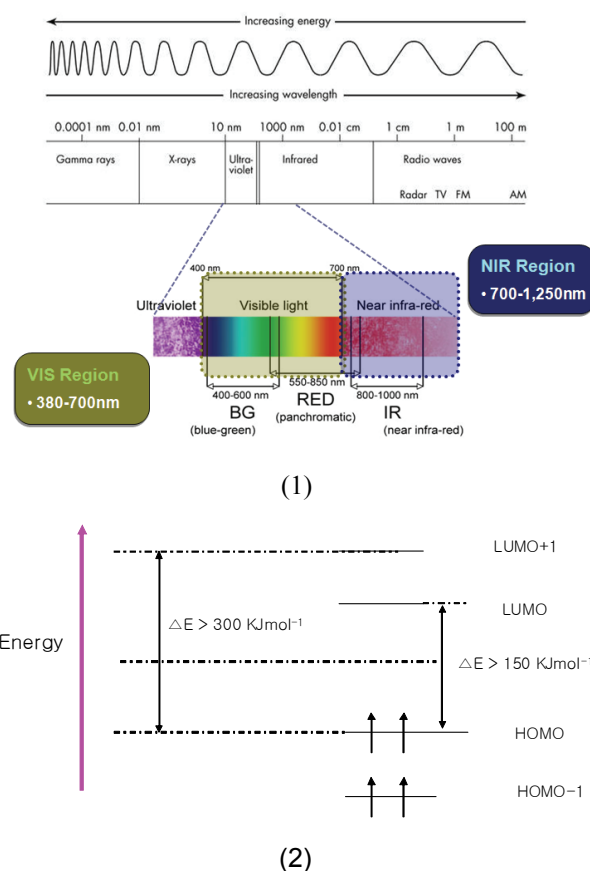


Fig. 1. The absorbing wavelength for an uv-vis and near-infrared region (1) and disposition of molecular orbitals for a near-infrared dyes (2)

3. EXPERIMENT and DISCUSSION

The major dye classes that give rise to infrared absorbing dyes are i) cyanine-type dyes, ii) donor-acceptor chromogens, iii) metal complex dyes. The synthetic compounds in the main infrared dye classes will now be reviewed.

The light absorption properties of all near-infrared dyes classes prepared in this research work have been examined.

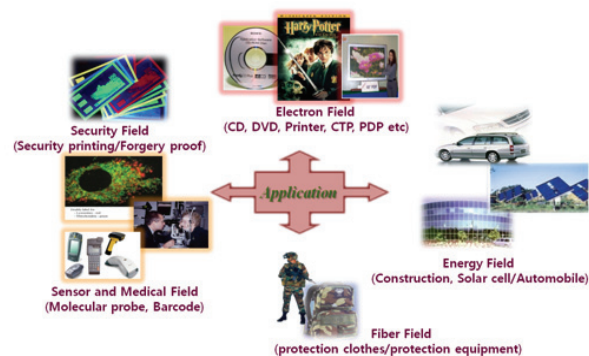
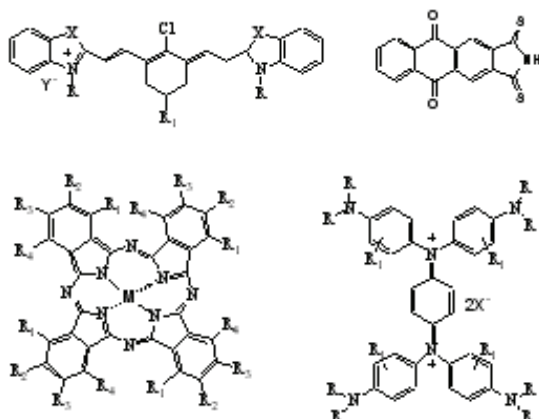


Fig. 3. Application of NIR dyes.

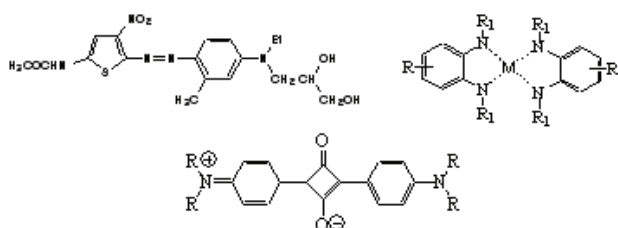


Fig. 2. Examples of infrared absorbing chromophores.

4. CONCLUSION

In our results, Several new near-infrared chromophores were synthesized with a view to examining their color properties. It should be noted that good near-infrared dyes should; i) a large bathochromic shift of the light absorption band, ii) a high intensity, iii) narrow band with, iv) minimal secondary absorption in the visible region. The near-infrared dyes have been used in high technology. Some typical uses include i) solar screens (car windscreens and windows), ii) laser screens (military uses and protective goggles), iii) solar heating (salt water evaporation and horticultural plastics), iv) optical data storage, v) thermal imaging processes, vi) infrared camouflage, vii) security printing, viii) machine readable systems, ix) laser dyes.

5. REFERENCES

- [1] R. Fabian and H. Hartman, "Light Absorption of Organic Colourants," Berlin, Springer Verlag, (1980).
- [2] D. M. Sturment, D. W. Heseltine and T. H. James, "Sensitizing and desensitizing dyes-the theory of the photographic processes," 4th ed, New York, (1977).
- [3] M. Matsuoka ed., "Infrared Absorbing Dyes," New York, Pleum Press, (2003).
- [4] J. Fabian, H. Nakazumi and M. Matsuoka., *Chem Rev* 92, 1197-1226, (1992).
- [5] R. F. Haugland, "Handbook of fluorescent probe and research chemicals," 7th ed. Molecular Probes. (1999).
- [6] Y. Kobayashi, M. Koto and M. Kurahashi., *Bull. Chem. Jpn.*, 59, 311, (1986).
- [7] J. Bernstein, M. T. Kendra and C. J. Kekhardt, *J. Phys. Chem.*, 90, 1069, (1986).