



# Microwave Synthesis of Cyanine Dyes

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## ABSTRACT

Heptamethine cyanine dyes are a class of near infrared (NIR) dyes that have captured the interest of the scientific community. Although applications that utilize NIR fluorescence technology are rapidly expanding, progress is limited by the lack of availability and cost of suitable compounds that can be utilized as labels and/or probes.

Herein, we report the use of microwave assisted organic synthesis of five NIR cyanine dyes in yields ranging from 64-83% with a significant reduction in solvent use. Spectra characteristics including absorbance and emission spectra, molar absorptivity, quantum yield, fluorescence lifetime, and redox potentials were determined for each synthesized NIR cyanine dye.

**KEYWORDS:** Cyanine dyes, microwave synthesis, fluorescence

## INTRODUCTION

Fluorescence spectroscopy has become a key technique for the detection and elucidation of biological processes. Most fluorescence sensors for bio-analytical applications fluoresce in the visible region (400-650 nm) [Wher, 1976]. A disadvantage of this technique is that most biomolecules also fluoresce in this region, causing significant background interference. Near infrared (NIR) dyes, however, fluoresce in the 650-1000 nm range with minimal background interference from biomolecules and high sensitivity [Hammer et al., 2002]. In particular, cyanine dyes have widespread application as fluorescent probes. The spectral properties of fluorescent probes assist in the determination of how they are applied in a variety of analytical techniques. Properties such as wavelength absorbance and emission ranges, Stokes shifts, and spectral bandwidths are used to address the various requirements associated with different analytical techniques. The characteristic low quantum yields of these dyes suggest they have potential applications in metal enhanced fluorescence related techniques. Metal enhanced fluorescence (MEF) is a form of fluorescence where plasmon waves generated by metals deposited on a glass substrate can increase the fluorescence of fluorophores within the influencing range of the wave. The phenomena is demonstrated most effectively in fluorophores that have low quantum yields. Because of the energy associated with the longer wavelengths of the NIR, and the low quantum yields associated with this class of compounds, the potential application for these compounds as MEF probes or labels are promising [Lakowicz et al., 2004; Lakowicz et al., 2003]. While these dyes are well-known, they are costly with limited commercial availability. Currently less than 1% of cyanine dye literature is concentrated on heptamethine derivatives. Further, while applications that utilize NIR fluorescence technology are rapidly expanding, progress in this area is limited by the lack of availability of suitable compounds that can be utilized as labels and/or probes.

The two primary methods of synthesizing cyanine dyes requires heating a mixture of a substituted quaternary salt (I) and either a bisimine or bisaldehyde to reflux in 1-butanol and