

Abstract No. bark0137

Synthesis, structure and spectroscopic characterization of novel near-IR absorbing bacteriochlorophylls related to bacteriochlorophyll a

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Beamline(s): X25

Introduction: Studies on porphyrins and related compounds as photosensitizers in the field of photodynamic therapy suggest that long wavelength absorbing chromophores may have advantages in destroying deeply located malignant cells within neoplastic lesions. Thus, novel porphyrinic compounds with absorptions in the far red/near-IR region, particularly from 800-900 nm are optimal, since diode lasers can cause light activation in this region. In order to achieve such bathochromically shifted absorption maxima, many synthetic features have been recognized as important and incorporated into the molecular design of the drugs. Specifically, this work takes advantage of the already long wavelength absorption of demetallated bacteriochlorophyll a, and further modifies its exocyclic ring to extend π -conjugation around ring E, while retaining the acetyl group on ring A [1]. The combination of all these features results in a new class of photosensitizers with long wavelength absorptions in the near-IR region (865-891 nm). We have determined the structure of **1** (see Figure 1), which exhibits the most red-shifted absorption (891 nm) of any existing natural or synthetic bacteriochlorin derivative to date.

Methods and Materials: Single crystals of **1** were grown from mixtures of methylene chloride/methanol. Two datasets were collected at 100K by the rotation method using a Quantum 315 detector. The data were processed and merged with Denzo/Scalepack [2] and the structure was solved by SnB [3] and refined with SHELXTL [4].

Results: The X-ray structure of **1** provides unambiguous identification of its structure and the first stereochemical parameters for this new class of bacteriochlorins. The compound crystallizes with three independent molecules in the unit cell which display subtle differences in conformation and orientation of the side chains. The bacteriochlorin macrocycle is clearly the same in all three.

Conclusions: The structure forms the basis for calculations that serve to test theoretical treatments and to predict the properties of new porphyrins. Theoretical calculations based on the X-ray coordinates predict a range of 792-872 for the long wavelength absorption [5]. The conformer that yields the best calculated agreement with the experimental value of 891 nm and presumably resembles most closely the conformation in solution is shown in Figure 2.

Acknowledgments: KB wishes to acknowledge support from the US Department of Energy, Office of Science, LTR Program. Financial support for X25 comes principally from the National Center for Research Resources of the NIH, and from the Office of Biological and Environmental Research and of Basic Energy Sciences of the US Dept. of Energy.

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Citations to previous work in this area are included in the manuscript.

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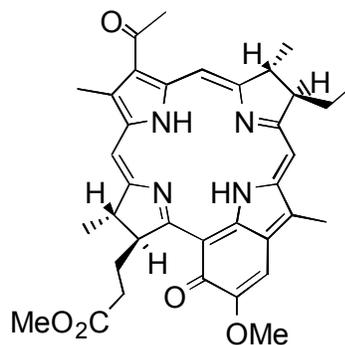


Figure 1. Structural formula for **1**.

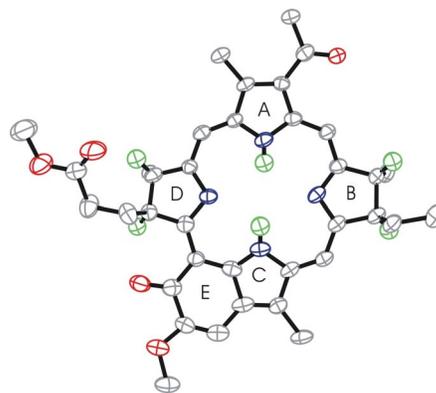


Figure 2. X-ray structure of **1**. Carbons are grey, nitrogens blue, oxygens red. Hydrogens (green) have been omitted, except for those on the reduced rings, and on the central nitrogens.