

CONF-900530--3

UCRL-102644
PREPRINT

Received by OSTI

FEB 05 1990

Demonstration of Temperature-Insensitive
Harmonic Generation in Deuterated
L-Arginine Phosphate

UCRL--102644

DE90 006262

Charles E. Barker

David Eimerl

Stephan Velsko

This paper was prepared for submittal to
CLEO '90, Anaheim, CA, May 21-25, 1990

December 13, 1989

Lawrence
Livermore
National
Laboratory

This is a preprint of a paper intended for publication in a journal or proceedings. Since changes may be made before publication, this preprint is made available with the understanding that it will not be cited or reproduced without the permission of the author.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

**Demonstration of Temperature-Insensitive Harmonic Generation
in Deuterated L-Arginine Phosphate**

Charles E. Barker, David Eimerl, and Stephan Velsko

Lawrence Livermore National Laboratory

P. O. Box 808; M.S. L-250

Livermore, CA 94550

(415) 423-3282

The thermo-optic coefficients of deuterated l-arginine phosphate indicate temperature-insensitive phase-matching directions for second-harmonic generation. We present direct measurements that partially agree with these predictions, and provide an explanation of the discrepancies between predicted and measured behavior.

Work performed by the Lawrence Livermore National Laboratory under the auspices of the U. S. Department of Energy Contract W-7405-Eng-48 and the Defense Advanced Research Projects Agency Order No. 5358.

Demonstration of Temperature-Insensitive Harmonic Generation in Deuterated L-Arginine Phosphate

Charles E. Barker, David Eimerl, and Stephan Velsko

Lawrence Livermore National Laboratory

P. O. Box 808; M.S. L-250

Livermore, CA 94550

(415) 423-3282

Efficient frequency conversion of high power laser radiation requires materials that possess significant nonlinear coefficients, high damage threshold, and the capability to phase-match, with reasonable angular bandwidth, the interaction between the fundamental and harmonic waves. Deuterated L-arginine phosphate (d-LAP) is a very promising new crystal for use in harmonic frequency conversion devices for Nd^{3+} lasers.¹ In addition to having a larger nonlinearity than KDP, d-LAP possesses another property that is quite attractive for high average power applications: the existence of temperature-insensitive phase-matching directions. In general, biaxial materials, such as d-LAP, are far more likely to demonstrate temperature-insensitive phase-matching directions than uniaxial crystals, such as KDP. Biaxial materials must satisfy far less stringent relationships between refractive indexes and thermo-optic coefficients than uniaxial materials in order to exhibit this property. For efficient high average power frequency conversion, careful management of the thermal loading of the conversion crystal is essential.² The presence of phase-matching directions with large thermal bandwidth greatly eases the requirements for crystal temperature control.³

In the principle planes, the reported thermo-optic coefficients of d-LAP¹ predict relatively large changes in the phasematching angle as a function of temperature for both type I and II phase-matching processes. Furthermore these rates of phase-matching angle change have opposite signs in the two principle planes. This behavior indicates the existence of temperature-insensitive phasematching directions.

Utilizing a modelocked, Q-switched Nd³⁺:YAG laser and a very high quality, spherically shaped sample of d-LAP mounted in a goniometer, we measured directly the change in phase-matching angle as a function of temperature in the principle planes. The values we have obtained, shown in Table 1, from this procedure directly indicate the presence of temperature-insensitive directions for type I phase-matching of second harmonic generation of 1.064 μ m light. Using this same apparatus, we have also accurately mapped the entire phase-matching locus for both type I and II second harmonic generation. By fitting these locus maps to a very simple analytical approximation, we have been able to predict the approximate location of the temperature-insensitive directions for type I phase-matched second harmonic generation.

Although our measurements do indicate temperature-insensitive phase-matching directions in the type I second harmonic generation locus, the values we measure for the rate of change of phase-matching angle with respect to temperature in the principle planes disagree significantly with the predictions made from the early thermo-optic data¹. Furthermore, our direct measurements indicate that there are no temperature-insensitive phase-matching directions for type II second harmonic generation. The source of this discrepancy lies in the highly anisotropic thermal expansion of d-LAP,

which requires the thermo-optic coefficients obtained from minimum deviation measurements be corrected for thermally-induced changes in the prism angles of the samples.

References:

1. D. Eimerl, S. Velsko, L. Davis, F. Wang, G. Loiacono, and G. Kennedy, "Deuterated L-Arginine Phosphate: A New Efficient Nonlinear Crystal," IEEE J. Quantum Electron., vol. QE-25, no. 2, pp. 179-193, Feb. 1989.
2. D. Eimerl, "High Average Power Harmonic Generation," IEEE J. Quantum Electron., vol. QE-23, no. 5, pp. 575-592, May 1987.
3. D. Hon, "High Average Power, Efficient Second Harmonic Generation," in Laser Handbook, vol. 3, ed. M. L. Stitch, (North Holland Publishing Company, Amsterdam, 1979), pp. 421-484.

Table 1. Measured values of the rate of change of phase-matching angle with respect to temperature in the principle planes.

nonlinear process	measured value of $d\theta_{PM}/dT$ ($\mu\text{rad}/^\circ\text{C}$)	
	α - β plane	α - γ plane
Type I SHG	$+248 \pm 4$	-38.3 ± 1.9
Type II SHG	$+237 \pm 4$	$+30.9 \pm 2.0$