

ACD 6929
INVC.....MSA 8/10/97

**A HOT-PRESS MOULDED
POLY(METHYLMETHACRYLATE) MATRIX
FOR SOLID-STATE DYE LASERS**

YEE KWONG CHEONG

B.Sc. (Hons.)

Perpustakaan Universiti Malaya



A507341577

A Dissertation submitted in partial fulfillment
for the Degree of
Master of Technology (Materials Science)

Institute of Postgraduate Studies & Research
University of Malaya

May 1997, Kuala Lumpur

12.09.2000
Dimikrofilkan pada.....
No. Mikrofis.....14841
Jumlah Mikrofis.....81
HAMSIAH BT. MOHAMAD ZAHAR
UNIT REPROGRAFI
PERPUSTAKAAN UTAMA
UNIVERSITI MALAYA
UPR

Acknowledgments

My supervisor, Assoc. Prof. Tou Teck Yong, steered this work through its critical stages, and it is my pleasant duty to thank him for his guidance but more so for his patience. I am also indebted to my co-supervisor, Assoc. Prof. Ng Seik Weng, for straightening the dissertation, so that the printed work is now an august work of science. I am glad I can learn from both of them a little more of the structure of scientific thinking.

Mr. Tham Kwong Keong and Mr. Siew Wee Ong, the senior members of the laser research laboratory, were always around to help me with the high-voltage instruments. Mr. Loo Wat Tim, the best craftsman in the Institute, made the all-important mould, the pivotal gadget of this work. Mr. Law Hong Kee joined the laser team as a student, only to become my very good friend and confidante.

I thank the University of Malaya for the generous award of a studentship.

My parents have encouraged me to pursue my postgraduate degree as did my younger brother, and only their noble sacrifices could have allowed my mind to wander freely through the corridors of science for so long. I dedicate this dissertation to all of them.

ABSTRACT

A hot-press moulding method was used for the fabrication of R640 (ClO_4)- and R6G (ClO_4)-impregnated poly(methylmethacrylate) (PMMA) dye lasers. The dyes were incorporated into the PMMA matrix by dissolving both the dye and PMMA in an organic solvent; evaporation of the solvent in a 175°C vacuum oven furnished a spongy material, which was then moulded into solid-state dye lasers of approximately 8% efficiency. R6G (ClO_4)-doped PMMA slabs suffered only a <10% drop in efficiency after having been operated for 850 pulses at 0.3 Hz. Moulding the preform at <1 mbar eliminated the formation of air bubbles in the slabs, and annealing the slabs minimised light scattering caused by the presence of adventitious solvent trapped in the matrix. The thermal stability of the dyes and the operational lifetime of the dye lasers depended on the nature of the solvent system that was used in the preparation of the preform. This study documents the first example of the use a hot-press moulding procedure for solid-state dye lasers that completely eliminates the radical-initiated decomposition of dyes, a problem associated with conventional fabrication methods in which the monomers are polymerised in the presence of the dyes.

CONTENTS

ACKNOWLEDGMENTS	II
ABSTRACT	III
CONTENTS	IV
CHAPTER 1 INTRODUCTION	1
1.1 Introduction to dye lasers	1
1.2 Review of solid-state dye lasers	3
1.3 Hot-press moulding of dye-doped PMMA	7
1.4 The present project	9
CHAPTER 2 LOW-PRESSURE-COMPRESSION MOULDING FOR DYE-DOPED PMMA SLABS	10
2.1 Materials	10
2.1.1 PMMA	10
2.1.2 Laser dyes	12
2.1.3 Solvents	13
CHAPTER 3 EXPERIMENTAL	26
3.1 Pumping of dye-doped PMMA slabs	26
3.2 Laser spectral measurements	28

3.3	Laser output energy measurements	29
3.4	Nitrogen lasers	31
3.5	Absorption and fluorescence measurements	38

CHAPTER 4 PERFORMANCE OF DYE-DOPED PMMA LASERS 40

4.1	Preliminary experiments	40
4.2	Effect of dye concentration, pumping energy and pumping power on laser efficiency	44
4.3	Effect of dye concentration on peak laser wavelength	49
4.4	Photo bleaching	50
4.5	Thermal degradation of dyes during fabrication	53
4.6	Summary	60

REFERENCES 61