PREFACE

Laser-induced damage is the principal limiting constraint in the design and operation of high-power laser systems used in fusion and other high-energy laser applications. Therefore, an understanding of the mechanisms which cause the radiation damage to the components employed in building a laser and a knowledge of the damage threshold of these materials are of great importance in designing a laser system and to operate it without appreciable degradation in performance. This thesis, even though covers three distinct problems for investigations using a dye Q-switched multimode Nd:glass laser operating at 1062 nm and emitting 25 ns (FWHM) pulses, lays its main thrust on damage threshold studies on thin films. Using the same glass laser two-photon excited fluorescence in rhodamine 6G and generation and characterisation of a carbon plasma have also been carried out.

The thesis is presented in seven chapters. The first chapter contains a detailed description of the fabrication and output characteristics of the Nd:glass laser which operates both in the conventional and dye Q-switched modes.
Chapter 2 gives a detailed account of the damage mechanisms in materials with particular emphasis on thin films. The first part of the chapter contains the theoretical aspects of laser damage to dielectrics covering the three distinct paths of avalanche ionization, multiphoton ionization and impurity induced damage. The latter part of this chapter, after a brief analysis of the damage in metals, discusses the characteristic features of transparent polymer materials and the various damage mechanisms in them. Of the various mechanisms of laser damage to transparent polymers, a brief outline of a mechanism associated with the viscoelastic properties of these materials has also been given.

The method of preparation, characteristics and laser-induced damage threshold measurement of some transparent-conductive coatings form the subject matter of Chapter 3. The films studied are tin oxide prepared by chemical vapour deposition and spray pyrolysis and indium tin oxide prepared by reactive rf sputtering.

Chapter 4 consists of three sections. The first section deals with the method of preparation and the damage threshold determination of polyacrylonitrile (PAN) films. In
the subsequent sections, the damage threshold measurement of dielectric and metallic coatings with and without an undercoat of PAN is given.

In Chapter 5 the two-photon excited fluorescence studies on rhodamine 6G in methanol at five different concentrations have been reported. A comparative study between one photon and TPE fluorescence has also been presented.

Chapter 6 discusses the experimental layout, production, detection and characterisation of a carbon plasma carried out using the Q-switched Nd:glass laser. Details regarding the fabrication of a vacuum system and a plasma chamber have also been given. Analysis of the laser-produced plasma made using a biased probe has also been presented.

The concluding chapter provides a summary and evaluation of the investigations presented in the earlier chapters. An assessment of the major results achieved during the course of the present studies is also made.
Part of the investigations presented in the thesis has been published/communicated in the form of following papers:

1. Concentration dependence of two-photon excited fluorescence emission in rhodamine 6G,

2. Laser-induced damage study of polyacrylonitrile films,

3. Laser-induced damage to spray pyrolysis deposited transparent conducting films,