

# PREFACE

Nearly forty-five years have passed since the discovery of the first nonlinear optical effect of second harmonic generation by Franken et al at the University of Michigan, Ann Arbor. Interest in this field has grown continuously since then. This field has expanded its span from fundamental studies of light-matter interaction to realization of numerous photonic devices. The development of quantum optics could explain the phenomena like optical antibunching by formulating field quantization whereas the nonlinear optical phenomena like optical parametric processes, optical phase conjugation, self-phase-modulation, self-focussing etc. could enrich the optical technology. Phase-matching is an important issue in those nonlinear optical processes where absolute value of susceptibility as well as the propagation of waves in the medium is involved. Thanks to the development of the technology of periodical poling of ferroelectric crystals, quasi-phase matching has been proved to be a potential method for efficient frequency conversion. But periodic poling can modulate only the even order nonlinear susceptibility tensor, not the odd orders because each index of the tensor transform like a vector. As such one cannot modulate the intrinsic third order nonlinearity by periodic poling of ferroelectric crystal. However, the cascaded second order process where two second order nonlinear optical processes occur simultaneously in a single crystal giving the effect of a third order process can exhibit the modulation of nonlinearity in periodically poled ferroelectric material. The effective nonlinearity derived from the coupled amplitude equations for the cascaded second order interactions is proportional to the product of the second order susceptibilities of each interactions. The novelty of work in the present thesis lies in the derivation and experimental verification of the effective nonlinearity of cascaded processes of second harmonic generation and sum-frequency generation for direct third harmonic generation in a

periodically poled lithium niobate. The thesis also explores the saturation absorber nonlinearity due to cascaded processes of second harmonic generation and difference-frequency generation in combination of a dichroic mirror. Some new nonlinear optical materials are characterized for their suitability in second and third order nonlinear optical devices.