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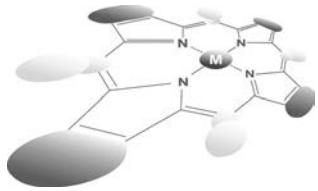

Third order nonlinear optical properties of phthalocyanines in the presence nanomaterials and in polymer thin films

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Dedicated to Professor Evgeny Luk'yanets on the occasion of his 75th birthday

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ABSTRACT: Third order nonlinear optical properties were determined for phthalocyanine complexes **1**–**10** containing In, Ga and Zn central metals and tetra- or octa-substituted with benzyloxyphenoxy, phenoxy, *tert*-butylphenoxy and amino groups at peripheral or non-peripheral positions. The phthalocyanines were embedded in poly (methyl methacrylate) polymer in the presence of CdTe quantum dots. All complexes **1**–**10** were studied in the presence of CdTe quantum dots and embedded in poly (methyl methacrylate) to form thin films. Complex **3** tetrasubstituted with *tert*-butylphenoxy groups at non-peripheral positions was also studied in the presence of CdS, CdSe quantum dots, fullerenes, single walled carbon nanotubes. Third order nonlinear optical parameters generally increase for Pcs in the presence of CdTe quantum dots.

KEYWORDS: phthalocyanine, nonlinear optics, CdTe quantum dots, poly (methyl methacrylate), fullerenes, single walled carbon nanotubes.

INTRODUCTION

Nanostructured materials have attracted exceptional interest over the past decades because of their unique architectures, tailored physicochemical properties, central roles in fabricating nanoelectronics and potential applications in bionanotechnology [1–3]. The use of nanomaterials (NM) in optical limiting (OL) and as nonlinear optical (NLO) materials has also attracted considerable attention [4–8]. Single walled carbon nanotubes (SWCNT), fullerenes and quantum dots (QDs) all show OL or NLO behaviour. Metallophthalocyanines (MPcs) have also been shown to be excellent OL or NLO materials with high absorption cross section ratio of excited triplet to ground states in the absorption range 400–600 nm [9, 10]. Combining MPc complexes with NM such as SWCNT, fullerenes or QDs is expected to result in enhanced NLO behavior of MPc complexes due to the synergistic effect, and this is the aim of the current work. It has been reported before that nonlinear response of phthalocyanines in the presence of multi walled carbon nanotubes (MWCNT) is due to both reverse saturable absorption (RSA) and nonlinear scattering, with these two conflicted mechanisms giving rise to suppression of the whole nonlinear response [11]. On the other hand, for SWCNT functionalized with porphyrins, an enhancement optical limiting performance was observed [12]. For graphene covalently functionalized with porphyrins and fullerenes, enhanced nonlinear optical performance was observed due to photoinduced electron or energy transfer between porphyrin or fullerene moiety and graphene [13, 14]. The reported data were in solution and the current work reports on third order nonlinearities in thin films. This is done in order to assess the effect on the combination of Pc with nanomaterials in thin films as opposed to solution. Also not much work has been reported for third order nonlinearity for Pc-QDs, apart from our recent report

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