

NANOSTRUCTURE IMAGING VIA BULK SECOND-HARMONIC GENERATION

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1. INTRODUCTION

As compared to conventional (linear) confocal optical microscopy, where a detector pinhole reduces out-of-focus contributions to the signal, nonlinear methods automatically restrict the probed region to the focus because of a nonlinear dependence on the incident light intensity. In addition, sample penetration depths are typically larger at longer wavelengths with less photodamage due to the lower photon energy. Thus, both multi-photon and multi-harmonic microscopy have gained interest for the characterization of biological and other nanostructured materials [1]. The methods have other advantages, however, both of spectral and structural interest. In particular, second-harmonic (SH) microscopy has proven successful to the imaging of interfaces and buried structures [2,3]. This is partly due to a strong sensitivity to sample regions with broken symmetry. Another important factor, however, is the signal generated in nonlinear substrates or bulk media themselves. In this contribution, SH imaging of nanostructures within a nonlinear medium is studied in order to reveal how bulk nonlinearities can be used advantageously to enhance the visibility of the structures.

2. MODEL AND DISCUSSION

A simple model of bulk SH generation driven by linear scattering from a point-like feature is discussed in order to elucidate the influence of various parameters and to facilitate the interpretation of experimental results. In particular, it is found that the phase-matching condition is less severe than in standard (plane-wave) SH generation, and that an effective volume of SH generation can be defined in a region surrounding such a nanostructure. The influence that this may have on imaging with high NA objectives of nonlinear samples is discussed and examples are given including the imaging of domain walls in quasi-phase-matching crystals often used for efficient SH generation [3].

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