





















According to Eq. (7), the local field effects take the form of a multiplication factor to both the surface (electric dipoles) and the bulk (magnetic dipoles, electric quadrupoles, etc.) contributions to the SHG intensity. The expected correspondence between the patterns of SHG sources and the patterns of local field enhancements at the fundamental frequency was experimentally verified, as shown in Fig. 3 and Fig. 4. Our results demonstrate that the origin of SHG in these structures is determined by the local field enhancements at the fundamental frequency.

### **5. SHG microscopy is an efficient technique for mapping local field enhancements**

In conclusion, while previous studies of the origin of SHG in metamaterials accurately predicted the overall SHG intensity for different polarized-analyzer configurations and dependence on quarter-wave plate rotation, they did not map the actual SHG sources on the nanostructures. In this paper we demonstrated that experimental mapping of the SHG sources matches very well with the results of numerical simulations of the local field enhancements at the fundamental frequency. Our results are in perfect agreement with the existing theoretical framework for SHG enhancements from local field factors. The numerical simulations presented here could be extended to the second harmonic response in order to reproduce the overall SHG intensity for different polarized-analyzer configurations and quarter- or half-wave plate rotation dependences.

From a practical point of view, our data demonstrate that SHG microscopy constitutes an imaging method for mapping local field enhancements in metamaterials. This new visualization tool is important because it has been instrumental in exploring the novel properties of chiral optical metamaterials. Also, SHG imaging is a very helpful technique as the images that were revealed from the nanostructures are surprising and counter-intuitive. Furthermore, our application of SHG is user friendly due to the fact that a commercial confocal microscope was adapted for SHG imaging and the samples followed a standard preparation procedure. Moreover, SHG imaging appears to be widely applicable since successful imaging was obtained from different shapes (Gs, Us, Ls and Is) and different materials, such as Au [33], Ni [44] and, most recently, Pd.

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