Circularly polarized high harmonics from solids originating from intraband dynamics

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Recently, we demonstrated that the polarization states of high harmonics from crystalline silicon can differ from those of the driving pulses [1, 2]. This is especially striking in the observation of circularly polarized high-harmonics with elliptically polarized single-color driving pulses. A time-dependent density functional theory approach is able to describe this behavior accurately [2]. However, its level of sophistication makes it costly and challenging to extract an intuitive picture of the underlying physics. Here, we therefore perform one-particle intraband-only calculations [3, 4] and find that we can reproduce some of the most striking phenomena. For instance, our calculations yield circularly polarized harmonics from elliptically polarized driving pulses that sensitively depend on the driving conditions, as well as a major-axis rotation of the harmonics' polarization ellipse. Furthermore, we perform measurements on ZnS which show qualitatively similar features to the ones observed in silicon. Our calculations show reasonable agreement with experiment, especially for large driver pulse ellipticities. Deviations can be attributed to missing interband transitions and scattering effects in our model. We also discuss qualitative differences in the behavior of above-band gap harmonics, where interband dynamics cannot be neglected. Our work proposes a method for the distinction of different generation mechanisms underlying high-harmonic generation from solids. Furthermore, it deepens our understanding on simple circularly polarized solid-state high-harmonic sources.

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