Supplementary Information:

Resonant harmonic generation in individual AlGaAs nanoantennas probed by cylindrical vector beams.

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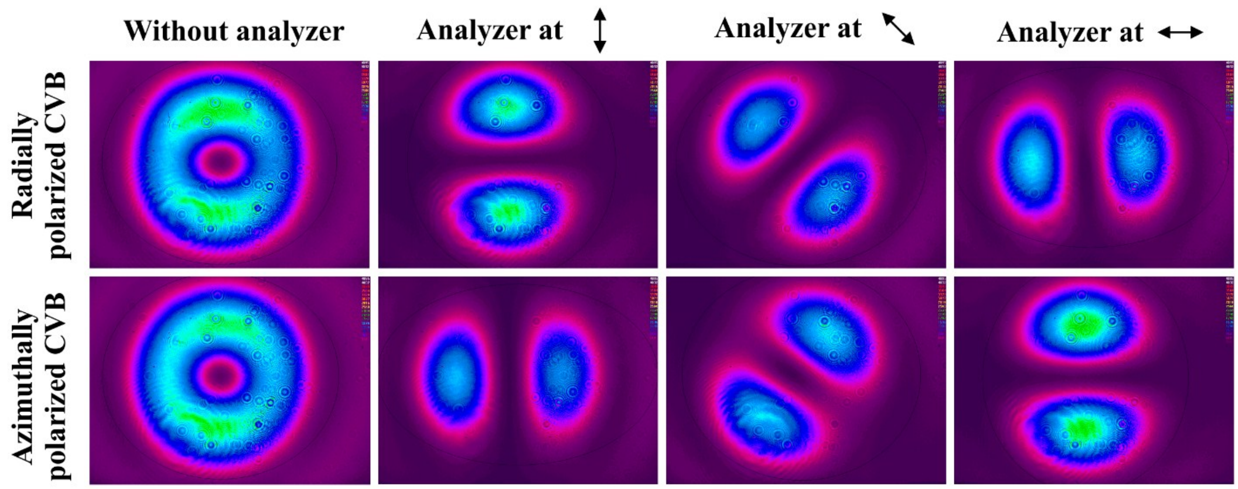

Figure S1. Transversal intensity profiles of the experimentally synthesized CVBs used in the SHG and THG microscopy experiments. The images were acquired using a beam camera and taken just before the microscope objective. The CVBs were verified by placing a linear polarizer (or analyzer) before the beam camera. Local intensity variations are attributed to the slight misalignment of the input beam and the CVB mode converter.

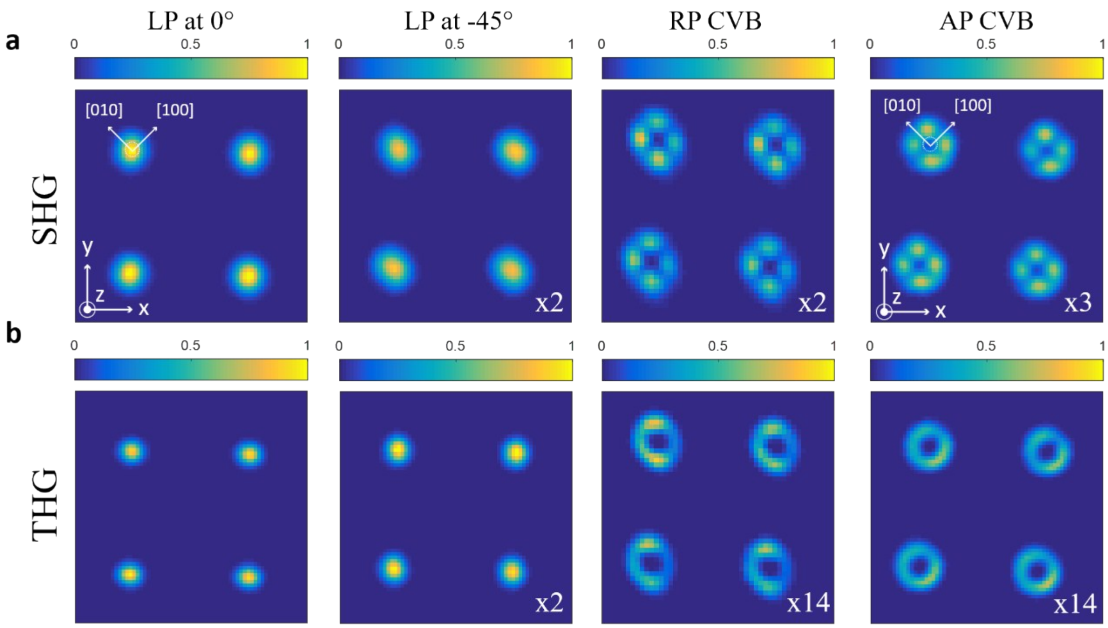

Figure S2. Experimental a) SHG and b) THG far-field scanning maps from AlGaAs nanodisks (*d*=716 nm) excited by a linearly polarized (LP) beam at 0° (i.e., along the x-axis), a LP beam at -45° (i.e., along the [010] crystal axis), a RP CVB and an AP CVB. In all measurements a constant input average power of 1 mW was used for direct comparison. All the relative SHG (THG) intensity images were plotted with respect to the maximum signal due to excitation of a LP beam at 0°.

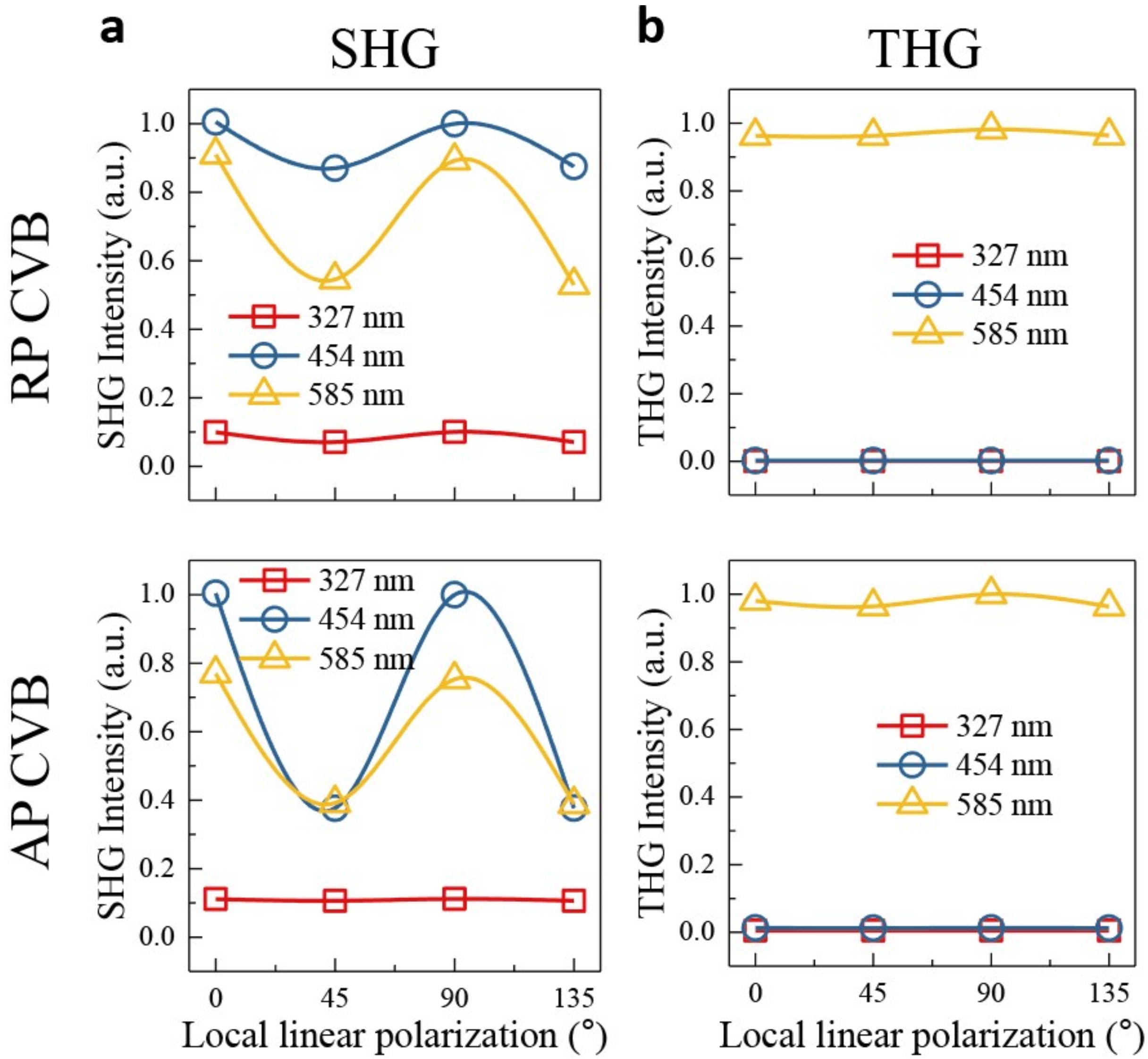

Figure S3. a) SHG and b) THG intensities of AlGaAs nanodisks with different diameters (*d*=340, 430 and 585 nm) excited by the local linear polarization of the corresponding CVB. The intensities (corresponding only to the four angles shown in Figure 3, for direct comparison) were extracted from the scanning maps simulated using the MoM.

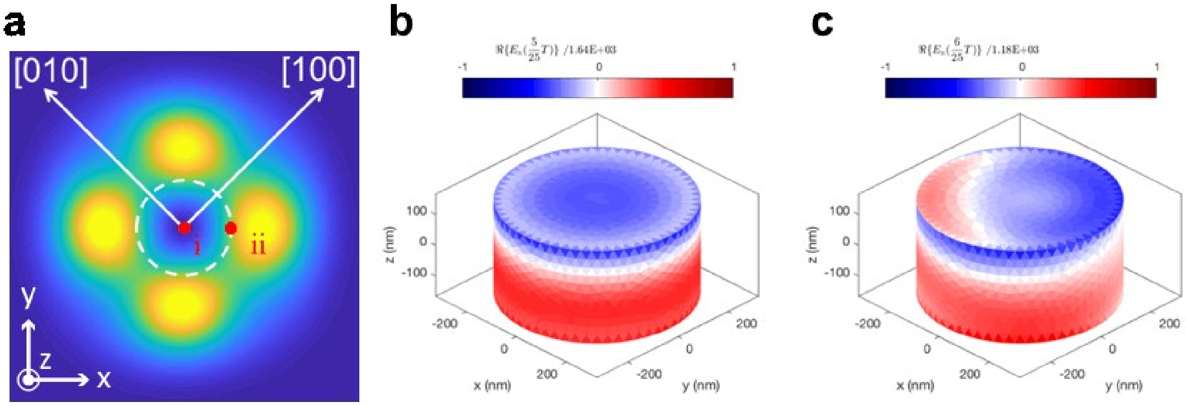

Figure S4. a) Illumination schematic with different focal points of a RP CVB. Number i denotes symmetric illumination and number ii denotes asymmetric illumination in x-direction by 400 nm. b-c) Near-field distributions at the fundamental frequency from an AlGaAs nanodisk (*d*=585 nm) when excited by a RP CVB: b) focal point of the beam at location denoted by i; c) focal point of the beam at location denoted by ii. The colormap gives the surface normal electric field and the excitation wavelength is 1060 nm.

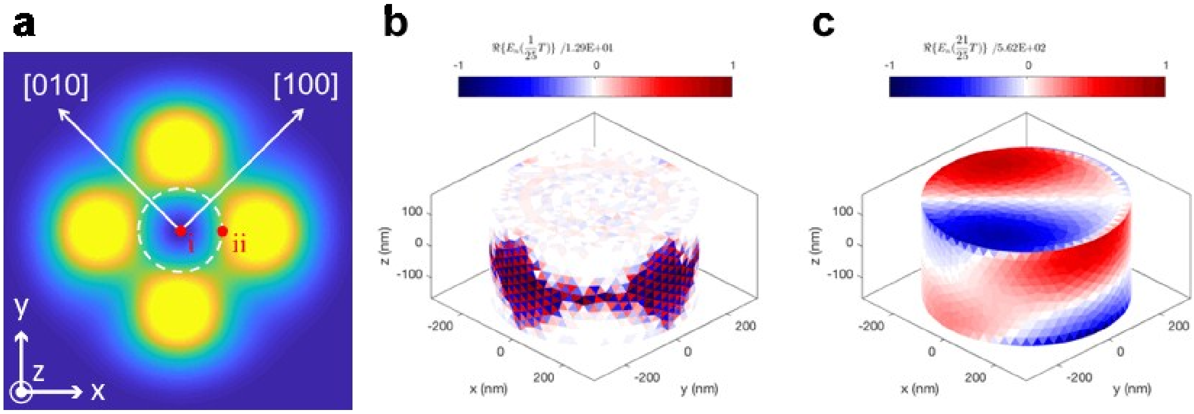

Figure S5. a) Illumination schematic with different focal points of a AP CVB. Number i denotes symmetric illumination and number ii denotes asymmetric illumination in x-direction by 400 nm. b-c) Near-field distributions at the fundamental frequency from an AlGaAs nanodisk (*d*=585 nm) when excited by a AP CVB: b) focal point of the beam at location denoted by i; c) focal point of the beam at location denoted by ii. The colormap gives the surface normal electric field and the excitation wavelength is 1060 nm.

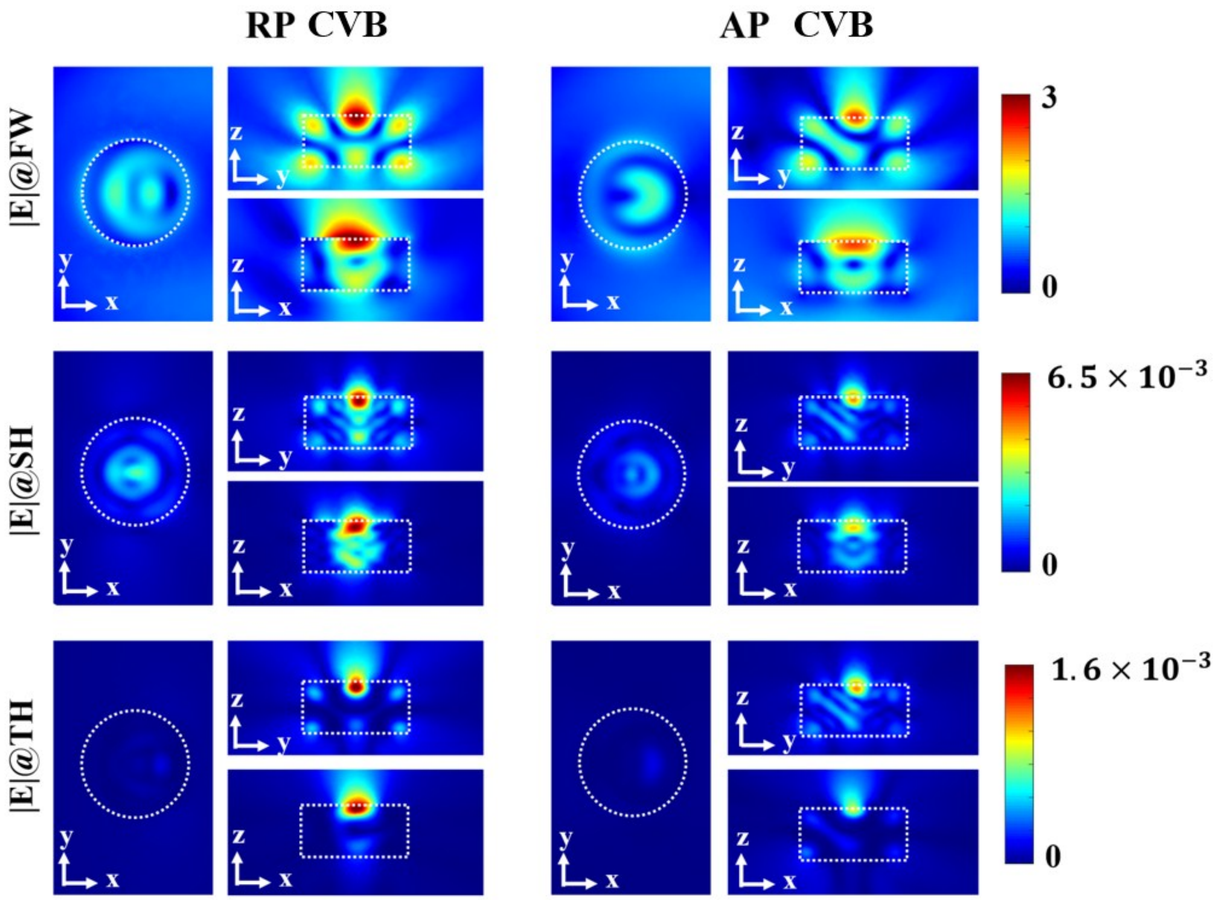

Figure S6. Electric near field distributions at the fundamental wavelength (FW), second harmonic (SH), and third harmonic (TH) signal from an AlGaAs nanodisk *(d*= 620 nm) excited by an offset RP and AP CVB. The beam is offset in *x*-direction by 500 nm. The crystal axes follow the same orientation with respect to the laboratory frames, as shown in Figure S2.

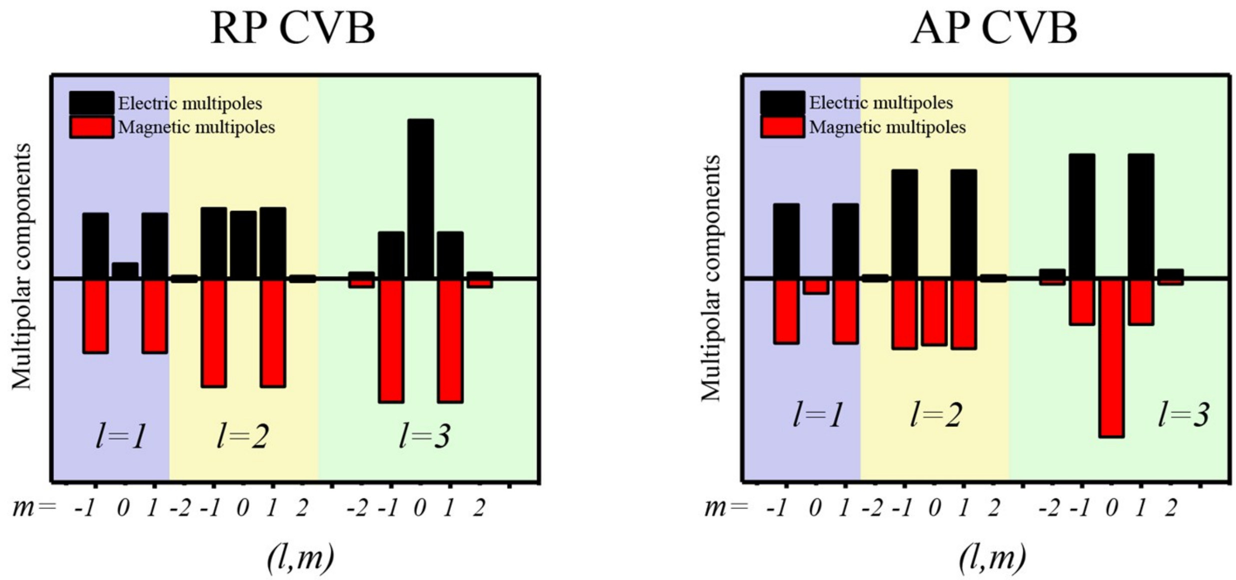

Figure S7. Multipolar components of an offset RP and AP CVB. In the calculations the beam is offset in *x*-direction by 500 nm. The laboratory and crystal frames are the same as in Figure S2.

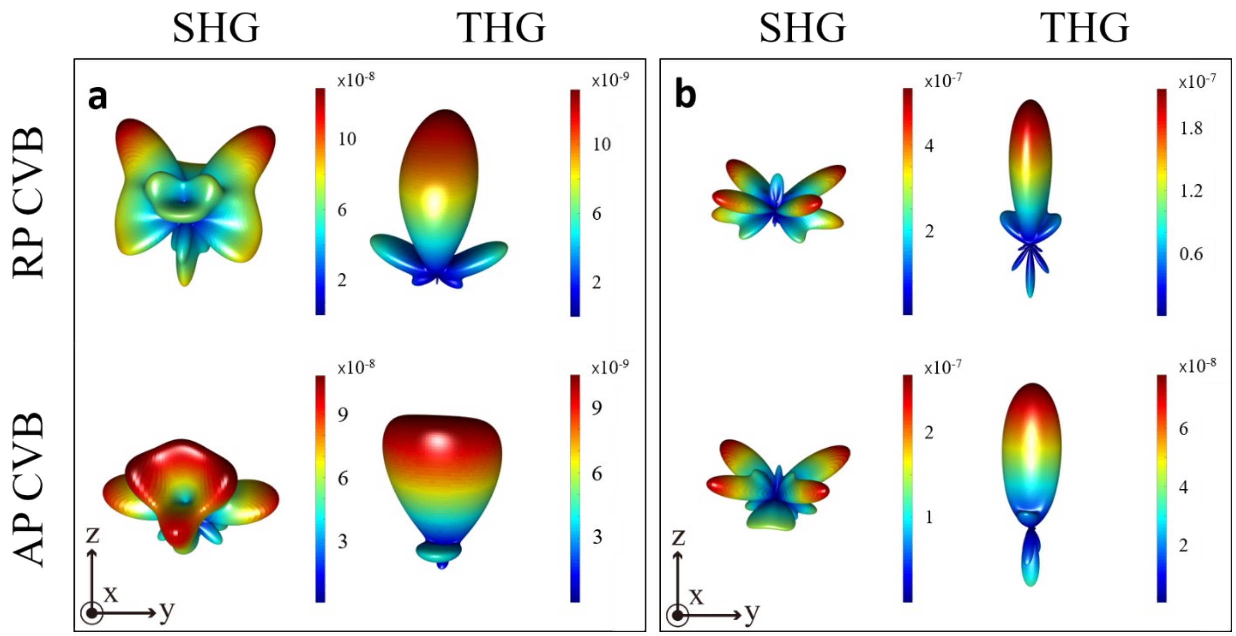

Figure S8. SHG and THG far-field emission patterns from an AlGaAs nanodisk with (a) d=430 nm and (b) d=620 nm. The nanodisk is excited by an offset RP and AP CVB with a wavelength of 1060 nm. In the calculations the beam is offset in x-direction by 500 nm (asymmetric excitation). The crystal axes follow the same orientation with respect to the laboratory frames, as shown in Figure S2.

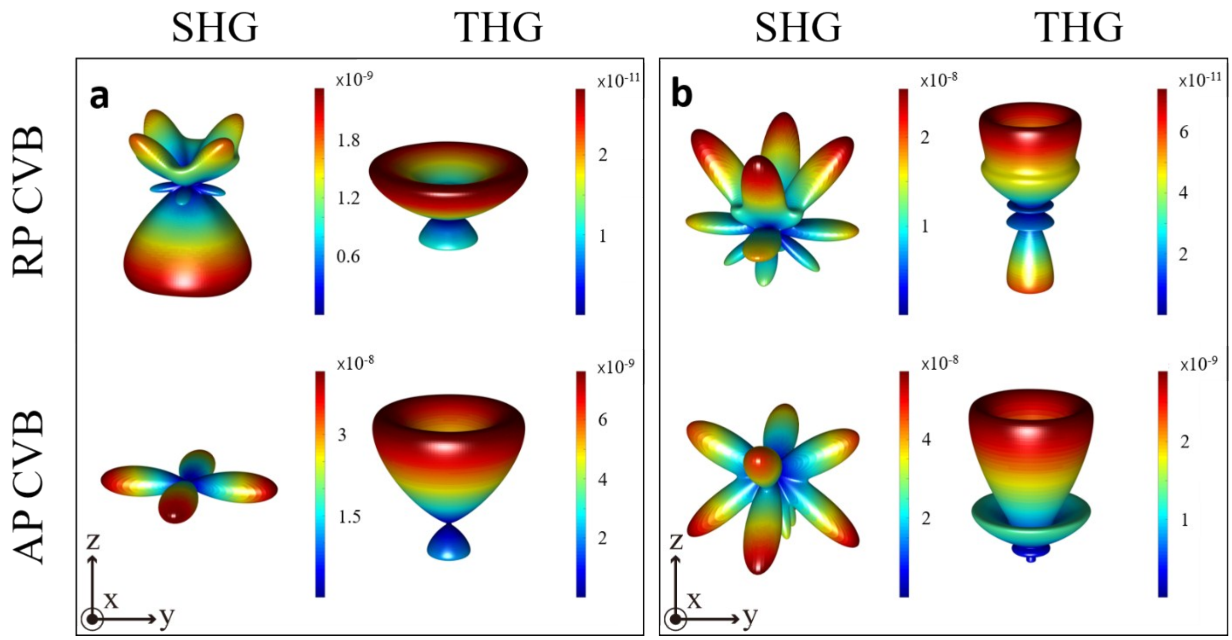

Fig. S9. SHG and THG far-field emission patterns from an AlGaAs nanodisk with (a) *d*=430 nm and (b) *d*=620 nm. The nanodisk is excited by a RP and AP CVB with a wavelength of 1060 nm (symmetric excitation). The crystal axes follow the same orientation with respect to the laboratory frames, as shown in Figure S2.