amplitude ratio of the parallel/perpendicular was ~2.5, which was approximate to the theoretical coefficient of 3 [21].

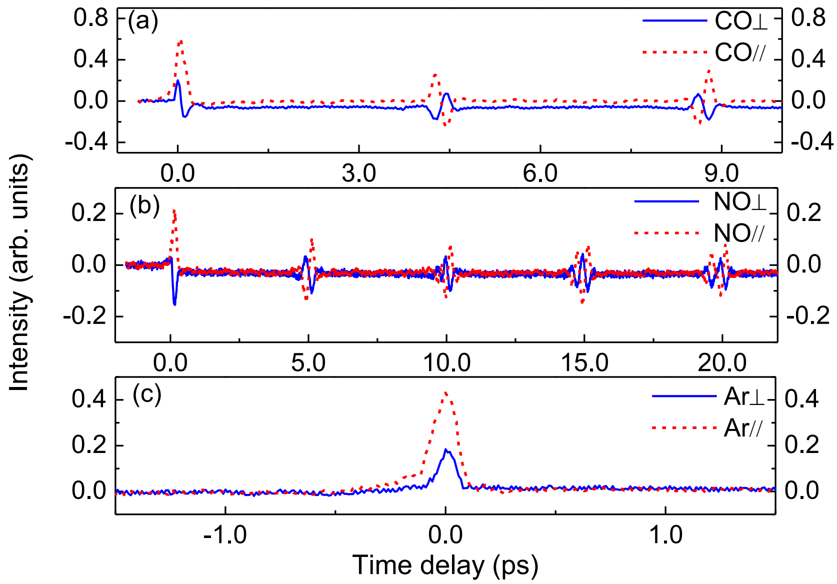

Fig. 4. Measured molecular alignment signals of (a) CO and (b) NO, and (c) Kerr effect of atomic Ar when the polarization of the probe pulse was perpendicular (blue-solid curves) and parallel (red-dashed curves) to that of the M-pulse (~4.6 × 10^{13} W/cm^2 for CO and Ar, 1.3 × 10^{13} W/cm^2 for NO).

In additional to the Kerr and molecular alignment effects, the weak ionization induced plasma contribution was also observed. The plasma contribution always defocused the probe pulse no matter its polarization was parallel or perpendicular to that of the M-pulse. The plasma contribution was involved since it was generated by the M-pulse and slowly decayed with a typical lifetime of the order of several hundred picoseconds to a few nanoseconds depending on the plasma density. It was actually almost a constant for the short time range of several to tens ps as concerned here [14,15]. This decreased the baseline of the measured signal, as shown in the figures, which was more prominent when the M-pulse and probe pulses were polarized perpendicularly where the permanent molecular alignment impact cooperated with the plasma effect to defocus the probe pulse. Since the NO molecules are very easy to be ionized, as shown in Fig. 4(b), the plasma effect induced decrease of the molecular alignment baseline was observed even when the probe pulse polarization was parallel to the M-pulse, where the weak permanent molecular alignment effect competed with the plasma effect. Actually, the alignment degree of molecular NO was small for the weak M-pulse intensity which made the plasma effect more evident as compared with the others.

4. Conclusion

In summary, we demonstrated that the field-free molecular alignment could be directly measured by the spatial (de)focusing effects, which clearly distinguished the parallel and perpendicular revivals with increased and decreased probe pulse intensity around the beam center. Meanwhile, the Kerr and plasma effects were observed and distinguished from the molecular alignment in our measurements.

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