

X-ray induced synthesis of novel optical materials at extreme conditions

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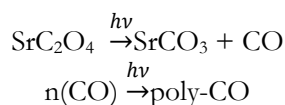
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We have demonstrated that highly ionizing, highly penetrating, and highly focused synchrotron hard x-rays (>7keV) can synthesize novel materials [1-2] and novel structures of materials [3] via *useful hard x-ray photochemistry*. We have also observed that some of these novel materials may have optical and electrical utility as wide bandgap material [4]. This material is a variant of polymeric CO which we call “doped poly-CO” that was produced by irradiating a relatively stable material (strontium oxalate powder) with synchrotron-produced hard x-rays (>7 keV) at ambient and high pressures generated by a diamond anvil cell (DAC) and a Paris Edinburg Cell (PEC). We suspect that the sequence of x-ray photochemical reactions that produced the novel material is as follows:



Here, we consider SrCO₃ as the dopant. This novel material appears to be very stable and does not decompose over periods of at least two years. It also traps CO₂ inside it for extremely long periods of time (> 2 years) - even when heated to 500K. We have produced doped poly-CO using different cations (Mg, Ca, etc) and using varying pressures. The synthesized products vary with pressure and irradiation flux and energy used and are all recoverable to ambient conditions.

We recently undertook a nonlinear optical study of doped poly-CO to examine its ability to withstand extreme conditions of photon flux in the desire to ascertain its viability as a sensor using 840 nm light as the excitation source. The smaller samples that were produced inside a pressurized DAC (~ 3 nl in volume) and recovered to ambient conditions deteriorated rapidly when irradiated by the high flux laser beam (in seconds). However, we observed that a larger sample (~3 μl in volume) that was synthesized by irradiation of SrC₂O₄ pressurized to 3 GPa in a PEC was not affected by the laser beam and exhibited Second Harmonic Generation (SHG) which was detected at 420 nm. This result suggests that our novel material may have practical relevance as a rugged easy-to-synthesize nonlinear optical generator or as sensor for extreme and ambient conditions.

REFERENCES

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