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Photo-oxidation of polymer-like amorphous hydrogenated carbon under visible light illumination

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Abstract

Amorphous hydrogenated carbon (a-C:H), a polymer-like network typically synthesized by plasma chemical vapor deposition, has long been known to exhibit optical absorption of visible light ($\lambda > 400$ nm). Here, we report that this absorption is accompanied by rapid photo-oxidation (within minutes) that behaves in most respects like classic polymer photo-oxidation with the exception that it occurs under visible light illumination rather than ultraviolet illumination. Lower plasma power during deposition produces a-C:H that is less crosslinked, is less absorptive, has longer photoluminescence lifetimes, and has a slower photo-oxidative degradation than a-C:H deposited at higher plasma power. The optical gap of the material deposited here is ~2.5 eV, and we correspondingly observe photo-oxidation at photon energies of 2.7 and 3.1 eV. A reduced photo-oxidative response is observed at sub-gap energies, suggesting that defect states or absorption tails enable absorption at lower energies. The photo-oxidation depends on both the total accumulated dose as well as the intensity of the illumination,