

# Study raises questions on what causes silicon solar cell degradation

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A widely accepted mechanism for silicon solar cell degradation requires the existence of two stable configurations of the oxygen dimer - but so far, researchers have found just one. Image credit: CrunchGear.

(PhysOrg.com) -- After several hours of exposure to sunlight, silicon solar cells experience light-induced degradation, which can decrease their efficiency by up to 10%. In a new study, scientists have attempted to detect the oxygen dimer ( $O_{2i}$ ) in the predicted charge state that is widely considered to play a key role in this light-induced degradation. However, their search has been unsuccessful, casting doubt on the accepted degradation mechanism of silicon solar cells.

The researchers, L. I. Murin, et al., from institutions in Belarus, the UK, Norway, Sweden, and Portugal, have published their study in a recent

issue of *Applied Physics Letters*.

Several previous studies have predicted that the light-induced degradation of silicon [solar cells](#) is related to  $O_{2i}$  interacting with substitutional [boron atoms](#) to form a  $B_sO_{2i}$  complex. This  $B_sO_{2i}$  complex can act as a powerful [recombination](#) center that can cause solar cell degradation.

Previous research has suggested that doubly positively charged  $O_{2i}$  can capture an electron that has been optically excited by incoming [photons](#) in p-type silicon, and that this event triggers a migration step via the Bourgoin-Corbett mechanism. In this mechanism, the  $O_{2i}$ 's motion is driven by transitioning between different charge states. So the mechanism requires the existence of two stable configurations of  $O_{2i}$  in different charge states.

Previous *ab initio* modeling studies have suggested the existence of two stable configurations of the dimer in silicon crystals with different doping: in n-type silicon, the dimer is in a neutral charge state, and in p-type silicon, the dimer has been calculated to be in the doubly positively charged state.

So far,  $O_{2i}$  has been detected in the neutral charge state, but never in the doubly positively charged state in any silicon material, although it has been predicted by theoretical modeling. In the current study, the researchers have performed a systematic experimental search for the absorption signature of the doubly positively charged  $O_{2i}$  by carrying out infrared absorption measurements on n- and p-type silicon, including those in which light-induced degradation attributed to  $B_sO_{2i}$  has been observed.

The researchers performed their own *ab initio* calculations to get a clue as to the possible location of local vibrational mode lines due to the

doubly positively charged  $O_{2i}$ . The calculations also revealed the expected intensity of the dimer's local vibrational modes for both the neutral and doubly positively charged states.

However, the researchers found no trace of the doubly positively charged  $O_{2i}$  in their sample set. Although their data did show the existence of the  $O_{2i}$  in the neutral charge state, the Bourgoin-Corbett diffusion mechanism cannot occur without dimers in both charge states.

Overall, the results cast doubt on the formation of the  $B_sO_{2i}$  complexes that have been widely thought to cause light-induced degradation of [silicon solar cells](#). The findings also suggest that alternative mechanisms for solar cell degradation deserve a closer look.

**More information:** L. I Murin, et al. "The oxygen dimer in Si: Its relationship to the light-induced degradation of Si solar cells?" *Applied Physics Letters* 98, 182101 (2011). [DOI:10.1063/1.3584138](https://doi.org/10.1063/1.3584138)

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