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Role of Defects and Their Analysis in Photovoltaics

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Defects are intrinsically related to the performance of solar cells. In solar cells the generation and collection of charge carriers determines their efficiency. Effective transport of charge carriers across interfaces and minimization of their recombination in the bulk or at surfaces and interfaces is of utmost importance. In this talk we will discuss the role of surface and bulk defects. First, the role of surface passivation is very important in limiting the rate of carrier of recombination. Here we will combine spectroscopic evaluation of the surface of a Si device with electrical lifetime measurements to ascertain what factors determine the quality of a solar cell passivation. We have also utilized time-resolved photoluminescence (TRPL) to assess the quality of materials grown under varying conditions. TRPL decay is best fit by a biexponential model that includes both the minority carrier lifetime and the rate of trap filling. At low laser powers the trap state recombination dominates and decay times are very short. At higher laser powers the trap states become saturated and we can extract the minority carrier lifetime. By evaluating the relative contributions of the trap-filling and minority carrier lifetimes we can assess the density of traps (defects) as a function of the growth conditions and guide refinement of growth recipes to improve material quality.