

# New limits for light-trapping in solar cells

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**We propose a new paradigm for light trapping in solar cells.** It aims at reaching nearly perfect optical absorption on a broad spectral range, with a number of resonant modes in periodical structures. We have developed a simple model for the calculation of the **multi-resonant absorption** maximum, called the multi-resonant critical coupling limit. A closed-form expression for the upper limit of optical absorption in a slab of semiconductor is provided.

**We demonstrate that the multi-resonant critical coupling limit exceeds the conventional Lambertian limit ( $4n^2$ ) for any absorber thickness (see Fig. 1).** These results could allow a drastic reduction of the absorber thickness in thin-film photovoltaics. We also provide numerical examples of multi-resonant absorption in various thin and ultrathin solar cells. These theoretical and numerical results are also supported by recent experiments on ultrathin GaAs absorbers and solar cells.

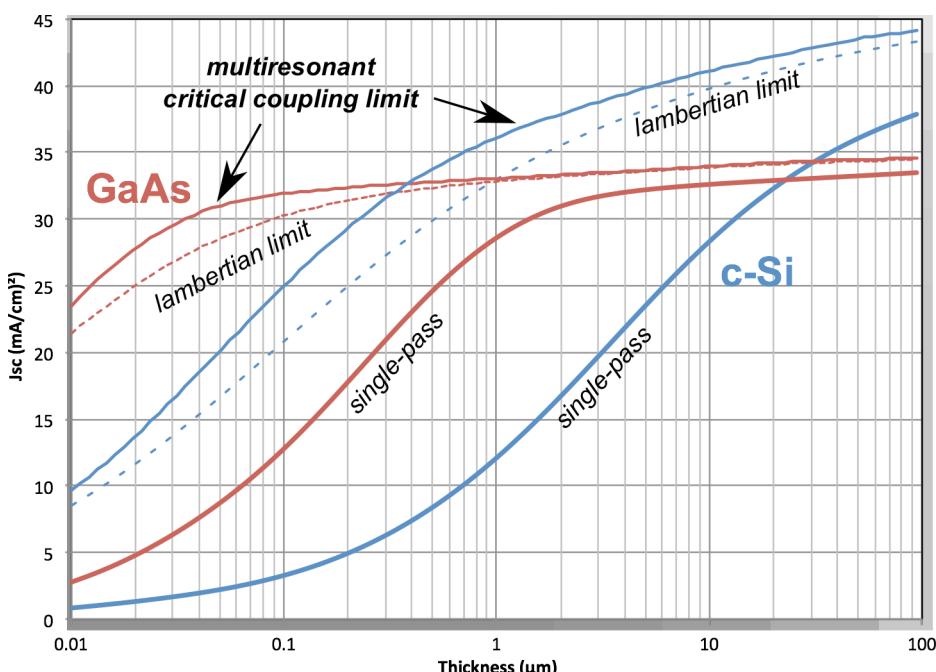


Fig. 1. Theoretical limits for the short-circuit current density calculated for a slab of GaAs (red) and silicon (blue) as a function of the thickness, for three different light trapping schemes: single-pass absorption with a perfect anti-reflection coating, Lambertian scattering, and multi-resonant critical coupling.