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Effect of double treatment based on Porous Si and TiO_2 passivation on the optoelectronic properties of monocrystalline Si substrates

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Abstract:

In this paper a novel passivation technique is proposed for monocrystalline silicon wafers for the purpose of solar cell application. The new method combines the use of double treatment based on porous Si and TiO_2 passivation. Porous silicon (PS) were prepared by electrochemical anodization of single crystal P type Si (100) substrates under different conditions of current density. It was demonstrated that the porosity increases with increasing current density from 27 66% to 81%. For comparaison some of the PS substrates were also subject to gettering treatment. TiO_2 nanoparticles with different nanometric sizes were incorportaed inside pores by pulsed laser deposition (PLD) technique. The obtained nanocomposite is investigated for its passivation and antireflection properties. We demonstrate that, in the 350 - 700 nm wavelength range, the total reflectivity decreases after treatment. The TiO_2/porous Si treated sample present a high photoluminescence intensity and an enhancement of the optoelectronic properties. This improvement is amplified for PS treated with TiO_2 presenting the smallest particles size. As a result, the effective minority carrier lifetime shows a strong enhancement after the combined treatment. AFM analysis shows a clear correlation between surface morphology evolution changes after each process and the minority carrier lifetime improvement.