The Fabrication and Characterization of Silicon Surface Grooving Using the CV Etching Technique for Front Deep Metallic Contact Solar Cells	
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Abstract: This study experimentally investigated the use of the chemical vapor etching method for silicon surface grooving for regular front deep metallic contact solar cell applications. The thickness of silicon wafers is a crucial parameter in the production of solar cells with front and back buried contacts, because silicon surface grooves result in a larger contact area, which in turn improves carrier collection and increases the collection probability for minority carriers. A simple, low-cost HNO3/HF chemical vapor etching technique was used to create grooves on silicon wafers with the help of a highly effective anti-acid mask. The thick porous layer of powder that was produced was easily dissolved in water, leaving patterned grooved areas on the silicon substrate. A linear dependence was observed between the etched thickness and time, suggesting that the etching process followed a constant etch rate, something that is crucial for ensuring precise and reproducible etching results for the semiconductor and microfabrication industries. Moreover, by creating shorter pathways for charge carriers to travel to their respective contacts, front deep contacts minimize the overall distance they need to traverse and therefore reduce the chance of carrier recombination within the silicon material. As a result, the internal quantum efficiency of solar cells with front deep metallic contacts improved by 35% compared to mc-Si solar cells having planar contacts. The use of front deep contacts therefore represents a forward-looking strategy for improving the performance of silicon solar cells. Indeed, this innovative electrode configuration improves charge carrier collection, mitigates recombination losses, and ultimately leads to more efficient and effective solar energy conversion, which contributes to sustainable energy development in the areas of clean energy resources. Further work needs to be undertaken to develop energy sustainably and consider other clean energy resources.