The impact of etching on the fracture strength of silicon wafers cut by diamond wires

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Crystalline silicon is an essential material for photovoltaic (PV) applications. Cutting silicon bricks into wafers is the first processing step in solar cells fabrication. To reduce the cost of wafer preparation for PV use, sawing industry has challenged two goals to reduce the saw dust (silicon kerf) and the wafer thickness. To achieve these goals, sawing industry shifted from loose-abrasive slurry to fixed-diamond abrasives on thinner wires with smaller abrasives than before [1-3].

As-sawn wafers have asymmetry in fracture strength as we reported that the strength values were quite different in tests parallel and perpendicular bending directions to saw marks [2, 3]. And it is interesting and practically important to understand how much etching will make “the parallel strength” and “the perpendicular strength” match.

After cutting 200 µm wafers using a 100-µm-core wire with 6 – 12 µm diamond abrasives, we conducted bending tests of sample wafers whose surfaces were etched by 3, 5 and 10 µm in 25% KOH aqueous solution. Also as-sawn wafers were included in the test. Fig. 1 shows that the etching of 3 and 5 µm improved the fracture strength by factors of 1.96 and 2.9 times in parallel test. On the other hand, the strength improvement was quite small (1.03 and 1.31 times) in perpendicular test. The fracture strength was approximately the same in both bending tests of 5 µm etched wafers and exactly the same in 10 µm etched wafers. We will discuss the result in the upcoming meeting.

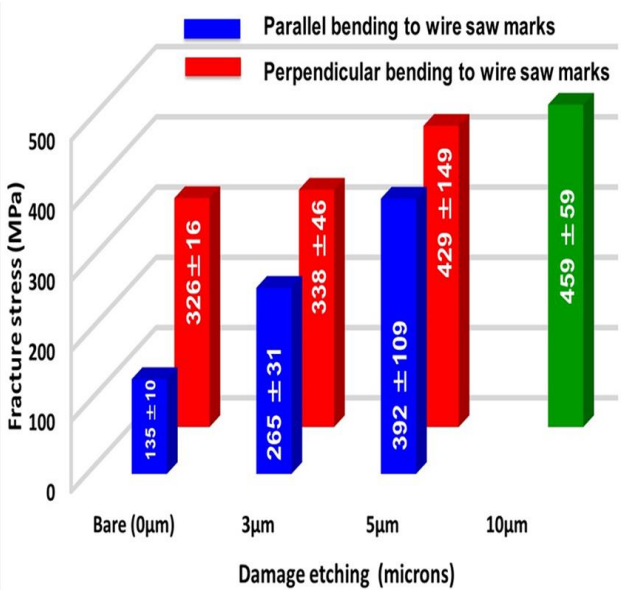

Fig. 1. Fracture strength of as-sawn and etched (3, 5 and 10 µm) wafers in parallel and perpendicular bending tests.

Reference:

1. International Technology Roadmap for Photovoltaic (ITRPV-2018, 9th edition)
2. H. Sekhar et al., “The impact of subsurface damage on the fracture strength of diamond-wire-sawn monocrystalline silicon wafers”, *Jpn. J. Appl. Phy.* **57 (8S3)**, 2018.
3. H. Sekhar et al., The impact of saw mark direction on the fracture strength of thin (120 µm) monocrystalline silicon wafers for photovoltaic cells” *Jpn. J. Appl. Phy.* 2018. (to be published).