The impact of silicon brick surface finish on the mechanical strength of diamond-wire-sawn thin wafers (120 µm)

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Present study mainly focuses on cutting thin silicon wafers from silicon bricks using thin diamond wires. To saw thin Si wafers with higher slicing yields, the wire should possess smaller sizes of diamond particles with high dispersion (or with low agglomeration) [1-3]. We have developed a diamond wire by matching above quality labelled as 100d-M6/12, where 100d represents steel wire diameter (100 µm) and M6/12 the size range of diamond abrasives (6 to 12 µm). To address the impact of surface finish of silicon bricks on the wafer fracture strength, we prepared two bricks, ground and mirror-polished ones. In wafer sawing, the thickness of as-sawn wafers and the kerf per wafer is the same, 120 µm respectively. As-sawn wafers are separated as fresh and worn-out wire sides. The wafers sawn from the ground brick (Figure 1 (a)) labeled as g-wafers and those from mirror-polished brick (Figure 1 (b)) as p-wafers. In three-line bending test, mechanical loads are applied perpendicular to wire saw marks on the middle of the wafer surface. We observed two fundamental differences in fracture strengths of p- and g-wafers as shown in Figure 1 (c). The g-wafers have lower strength compared to p-wafers. In both wafers, fresh wire side wafers have lower strength compared to worn-out wire side wafers. From fractrographical studies, cracks of low-strength wafers tend to propogates through short distance paths and break the materials at lower loads. In the wafers having higher fracture strength, cracks tend to propogates through longer and complex paths and break the materials at higher loads. In the meeting, we will discuss the reason why there is a large difference in strength between p- and g-wafers.

(a) (b)

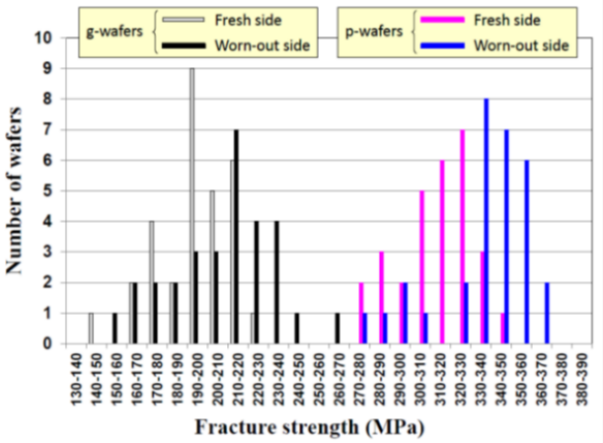

Figure 1. (a) A silicon brick with grinding surface, (b) one with mirror-polished surface and (c) fracture strength distributions of as-sawn g-wafers (in the left-hand side) and p-wafers (in the right hand side).

References:

[1] H. Sekhar et al. "The impact of subsurface damage on the fracture strength of diamond-wire-sawn monocrystalline silicon wafers", Jpn. J. Appl. Phys. **57**, 08RB08 (2018).

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