Characterisation of Directly Bonded Silicon Wafers by Means of the Double Cantilever Crack Opening Method

1 Introduction

- In many cases the double cantilever beam test (DCB test) is applied to measure the bond strength (figure 1). The strength is characterized in terms of the interface energy $\gamma$.

- For beam-like specimens the interface energy can be calculated from eq. 1.

$$\gamma = \frac{3E\gamma^3L^2}{8t^2}$$

$E$ : Young’s Modulus, $t$ : wafer thickness, $2\gamma$ : displacement, $L$ : crack length

- To examine the accuracy and to improve the significance and the reliability of the test the influence of the specimen geometry, of the crack detection method, of the anisotropic mechanical properties, and of the holding time during blade insertion on the results was investigated.

2 Experimental

- Czochralski-grown (100) silicon wafers (diameter 4 in., n-type, 525 $\mu$m thick) were bonded under hydrophilic conditions and annealed at various temperatures.

- DCB tests were performed on complete bonded wafers and on beam-like strips (figure 2).

- The crack length was measured utilizing IR-imaging and acoustic microscopy.

- The results, based upon eq. 1, were compared with numerical simulations using FEM and BEM.

3 Results and Conclusions

- If the determination of interface energy values of bonded samples is required the DCB-test is a widely employed and useful method.

- However, the results are affected by the sample geometry, resolution of crack detection, anisotropic mechanical properties and subcritical crack growth.

- If not appropriately accounted for, these effects can cause a total measurement error up to 20-80%.

- Thus, an interpretation and comparison of absolute interface energy values requires a careful consideration of the investigated factors by using appropriate testing conditions and evaluation procedures, as proposed in the paper.

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