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# Investigating Cracks in ATLAS ITk Strips

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The ATLAS ITk strip sensors employ silicon wafers, supported by carbon fiber staves with sandwich construction. The sensors are equipped with hybrid and powerboard flexes that are bonded with rigid adhesives. The sensor layout varies across different detector regions, including changes in wafer geometries, number and composition of the flexes, and adhesive layout. During preliminary cold testing of the first staves produced for the barrel section, high voltage testing failures were detected on several sensors. Upon visual inspection, these failures were found to be due to mechanical cracks propagating in the silicon wafer. In order to understand the origin of these cracks, analytical and numerical models were developed, reproducing the sensor assembly process, cooldown and operation. The results suggest that mechanical loads are introduced by the bonding procedure, and by the differential thermal contraction of the components. In particular, the silicon is captured in the middle of the larger shrinkage of the flexes, and the very stiff and stable carbon fiber stave constraint. This leads to bending motions and consequent large tensile strains in the unsupported silicon regions. In parallel, multiple measurement campaigns were performed to quantify the strength of the silicon wafers under different loading conditions, to check the crack morphology with CT scans, and to test the failure mechanism on simple but representative coupons. Finally, the models were used to evaluate different mitigation strategies aimed at reducing the mechanical loads experienced by silicon.

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