Project breakdown name

Specification of the carbon bridge

abstract

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Distribution List

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History of Changes

Rev. No.	Date	Pages	Description of changes
A	dd/mm/yy 09/03/01	All	First version Updated texts and the drawing for k4 hybrid

1 Introduction

Because of the finite resistance of the strips, the lower the input resistance due to the strip resistance the lower the intrinsic noise in the electronics. The layout where the readout electonics is connected at the centre of the strips, called “centre-tap geometry”, has a quater of the input resistance compared to the layout where the electronics is connected at the end of the strips, called “end-tap geometry”. In the SCT barrel modules, the front-end electronics are mounted on a copper /polyimide laminated flexible circuit, reinforced with a carbon substrate, and placed near the centre of the module to realize the “centre-tap geometry”. The circuit is bridging over the silicon detector in order to eliminate possible damage to the surface of the silicon sensor.

The substrate for the flexible circuit is required not only mechanically rigid but also highly thermally conductive in order to bring the dissipated heat in the front-end electronics to the cooling point. If the material is electrically conductive, it can help to reduce the resistivity of the ground of the circuit which improves the electrical performance of the electronics. The radiation length of the material needs to be as low as possible not to interfere the passage of particles. A carbon material, called “carbon-carbon” composite with unidirectional fibres, is chosen for the material of the substrate for its superb properties of mechanical rigidity, large thermal conductivity, very long radiation length and sufficient electrical conductivity.

This document specifies the material, dimensions, machining procedure and surface treatment of the carbon bridge. Acceptance criteria, i.e., Quality Assurance (QA), are also specified.

2 Quantity

In series production, a total number of 6,200 pieces are to be fabricated.

3 Material of the carbon bridge

Carbon-carbon with uni-directional fibres. A product is available from Nippon Mitsubishi Oil Corporation, catalog no. NCC-AUD28.

Table 1: Properties of Carbon-carbon

Material	Uni-directional fibres
Thermal conductivity (fibre direction) [W/m/K]	700 ± 20
Thermal conductivity (transverse to fibres) [W/m/K]	35±5
Density [g/cm^3]	1.9
Young’s modulus (fibre direction) [GPa]	294
Tensile strength (fibre direction) [MPa]	294
Thermal expansion coefficient (CTE) (fibre direction) [ppm/K]	-0.8
Thermal expansion coefficient (CTE) (transverse to fibres) [ppm/K]	10
Electrical resistivity (fibre direction) [Ωm]	2.5×10^{-6}

4 Dimensions of the carbon bridge

The dimensions of the carbon bridge is specified in Fig. 1. The thickness of the (thinner part of) bridge is chosen to be 300 μm, considering the mechanical rigidity, specially the rigidity for the wire-bonding (super-sonic wedge bonding of Aluminium wire), heat conduction, and radiation length. The mechanical rigidity and heat conduction demand thicker, while the radiation length demands thinner material.

5 Fabrication of the carbon bridges

5.1 Machining

The bridge is to be shaped with a milling machine, so that the steps of the bridge are part of the original material in order to eliminate an additional adhesive layer to maximize thermal conduction. To ensure rigidity and thermal conductivity, the orientation of fibres is parallel to the longitudinal direction of the bridge.

5.2 Coating with polymer

The surface of the bridge is to be coated with a polymer in order to insulate the surface and to improve reliability in handling. Parylene of 10μm thick is to be applied. The area where the electrical conduction is required is to be processed in 5.3.

5.3 Surface roughing and opening windows with a laser

As shown in Fig. 1, adhesion surfaces are to be roughened with a laser. In order to efficiently transfer the heat from the front-end electronics to the carbon-carbon, windows are opened in the polymer coated surface with a laser for direct thermal contact. Those windows are also used to improve hybrid grounding by making electrical connection between the carbon substrate and the ground of the flexible circuit.

6 Acceptance of the carbon bridges

6.1 Mechanical tolerance

Mechanical tolerance of the bridge is specified in Fig. 1. For instance, the thickness of the bridge is to be within 300 ± 30μm and the length to be within 74.6 ± 0.2mm.

6.2 Mechanical performance

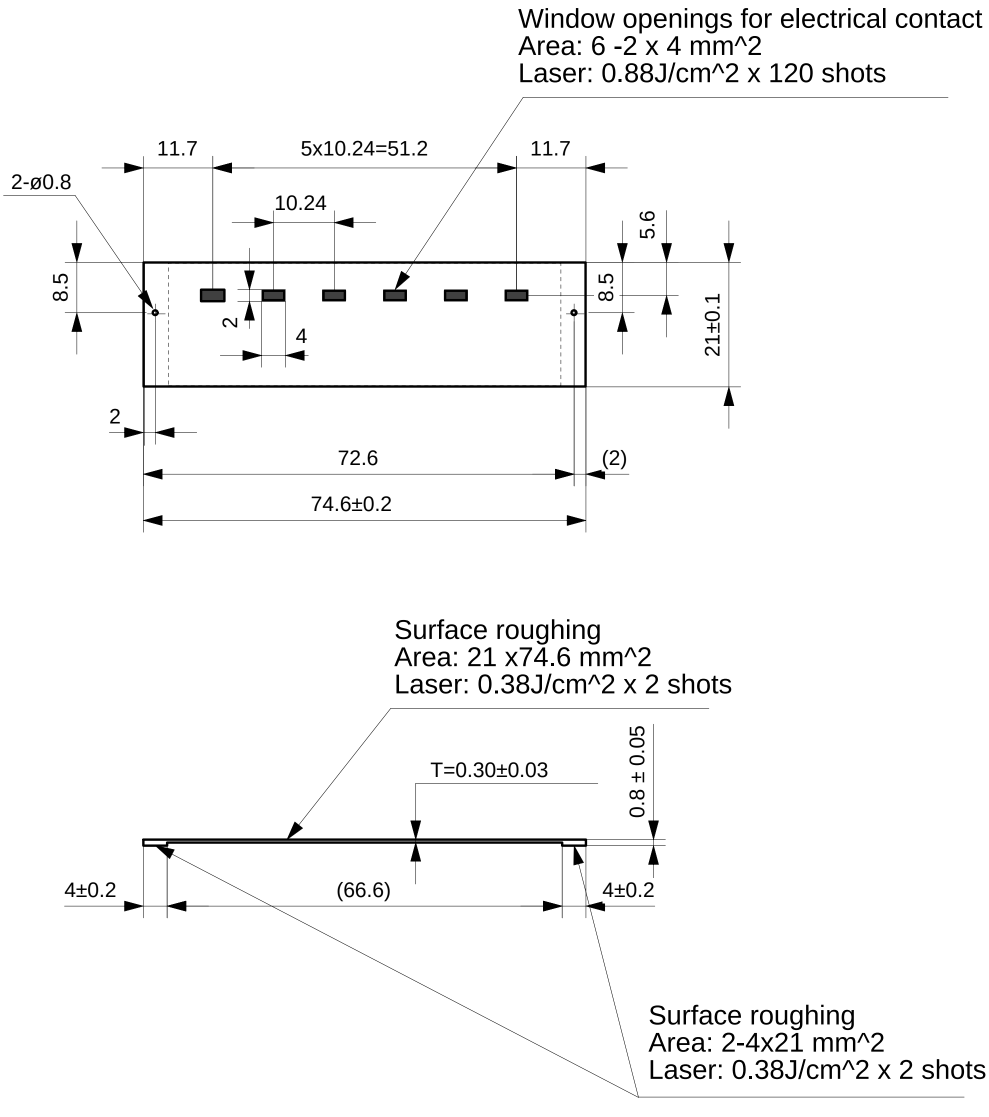
The bridge should be sample-tested to verify the rigidity requirements. Young's modulus and tensile strength of the bridge should surpass 90% level of the values specified in Table 1: 265 GPa and 265 MPa for Young's modulus and tensile strength, respectively.

6.3 Thermal property

The bridge is to be sample-tested to verify its thermal conductivity to be larger than 600 W/m/K.

6.4 Electrical conductivity

All bridges are to be examined. The polymer coating at the windows are completely removed so that the carbon surfaces are electrically exposed. Using those windows the resistance of the bridge should be measured: The resistance when measured using the two windows farthest apart (about 5 cm apart each other) should be smaller than 25 mΩ.



Laser processing: Tolerance ±0.3

Note the location of two ø0.8 holes

	TOLERANCES UNLESS STATED GEN. ±0.1	FINISH REMOVE ALL BURRS	ORIGINAL SCALE 1/1
	MATERIAL & SPEC. CC-bridge+Parylene(10µm)	SURFACE TEXTURE µm STOCK(UNLESS STATE)	QUANTITY - pieces
	TITLE CC-bridge+Parylene+Laser bridge2000	DRAWING No. A4-AT2k07-02	2k0201R0 T.Kohriki@KEK

Fig. 1 Specification drawing of carbon bridge

References

[1] Author(s), “Title”, reference id, date