

BRAIDED ELECTRICAL CONTACT ELEMENT BASED HIGH PERFORMANCE CONNECTORS

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ABSTRACT

Braided Electrical Contact Element or BeCe is high performance mechanically and electrically. It can be used in a variety of connector and interposer applications. This presentation discusses the use of BeCe in board-to-board, flex-to-board, and equivalent connectors. BeCe is typically braided with 6-12 wires and has OD 0.125-0.9 mm and height 1-4 mm. Because of the high elastic compliance, 25-30 % of the uncompressed height, a BeCe height of 2 mm is adequate for an array of 2000 I/O. The contact pitch has a range 0.2-2.0 mm. The average contact force for an array is 5-20 gr. per I/O. The contact resistance of 1 mm BeCe is 5-20 milliohm depending on the wire used. If copper plated stainless steel wire is used the service temperature can be > 250 C. Typical board-to-board connector is constructed by inserting BeCe array in a carrier for adhesive retention. Alternately, the BeCe is cut into two equal heights and each segment is solder attached to the top and bottom side of the FR-4 carrier. Only both ends of BeCe are exposed the remainder part of BeCe is inserted in the spacer above and below the carrier for hard stop to avoid overloading and for buckling prevention. When electrically connecting two parts it can be done with externally applied contact force and with both ends mating in a demountable way. Alternatively, the mounting can be done in a self-assembled mode, which will be detailed in the presentation. In the presentation the design, construction, and performance of board-to-board connector will be discussed in detail with performance data.

Keywords: electrical contact, electrical connector, board-to-board connector

Introduction:

What we mean by high performance is high frequency and high I/O at fine contact pitch where current available connectors are inadequate and are not extendable. For example, the widely used pin/receptacle connector is inductive and incapable of fine pitch area array that has equal pitch in both X-Y directions. Pin/receptacle connector does have one advantage that is capable of self-assembled without externally applied contact force.

Braided electrical contact element, BeCe is designed as several helical springs in operating parallel by braiding.

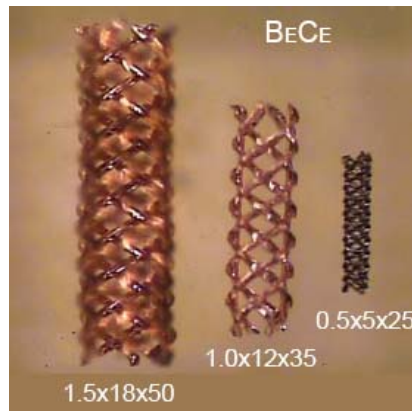


Fig. 1: BeCe samples

Fig. 1 shows examples of BeCe. The 3 BeCe shown with dimensions the first is the OD of braiding wire, the second, OD of the braid, and the last, the height of the braid all in mil are braided with 8 wires. The helical spring is known to have high elastic compliance so is BeCe. There are a number of single wire spring contacts in the market. For these connectors if the wire OD becomes thinner the bulk resistance of the contact will increase. However, BeCe does not suffer the same

because the bulk resistance of BeCe is that of a single spring divided by the number of braiding wire.

Typically the braiding wire has OD 0.5 – 2.0 mil. The OD of the braid will depend on the OD of the core wire used in braiding which is removed from the braid before cutting. For example, in Fig. 1 the BeCe shown has OD 5-18 mil. When used with a spacer buckling is avoided so that the cut height of BeCe can be as high as 20/1 over the OD the braid.

Performance of BeCe:

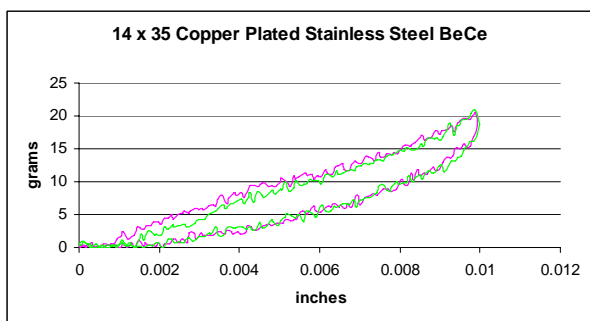


Fig. 2 Displacement Data

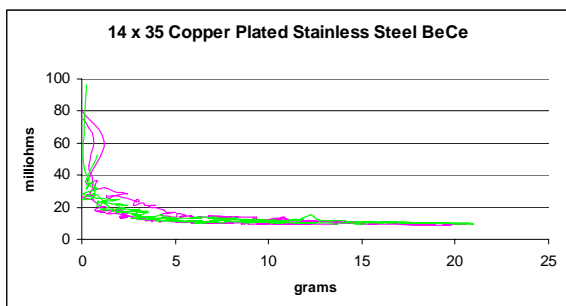


Fig.2 shows load-displacement data of copper plated stainless steel BeCe exhibiting high elastic compliance (25-30 % of the uncompressed height) and low resistance (10 milliohm and below per 40 mil at > 32 mil contact pitch) and contact force (10-20 gr. per BeCe typical). With the high elastic compliance, the contact needs not to be tall to achieve low inductance, which allows high frequency.

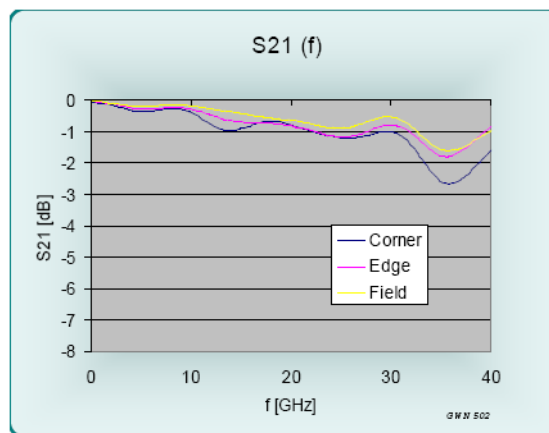


Fig. 3 Insertion Loss 5 X 5 Array, 1 mm Contact Pitch, 14 Mil OD, 40 mils Height

Fig.3 shows insertion loss data vs. frequency. At -1 db, the frequency is 30 GHz, which is not match by currently available contact with all the other additional attributes of BeCe.

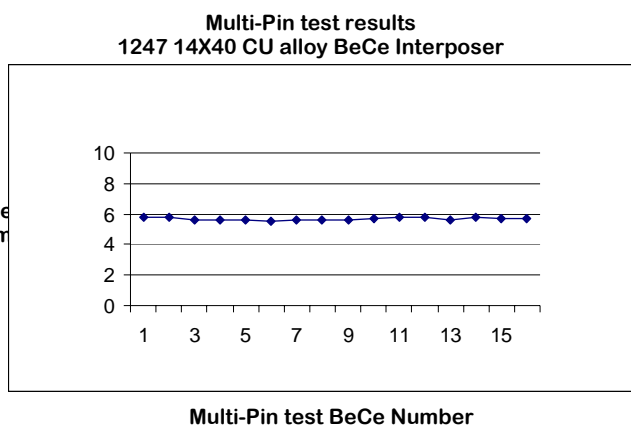


Fig. 4 Multiple pin Test data

Fig.4 shows the data of the resistance measurement of a large array of BeCe. The data suggest the low and uniform resistance. Other attributes of BeCe include large working distance (Fig.2), high durability, and high service temperature only with copper plated stainless steel BeCe. The working distance is defined as the maximum displacement or that allowed by elastic limit minus the displacement where the resistance stabilizes during initial loading. It is seen in Fig.2 the latter displacement is small in favor of a large working distance.

Interposer:

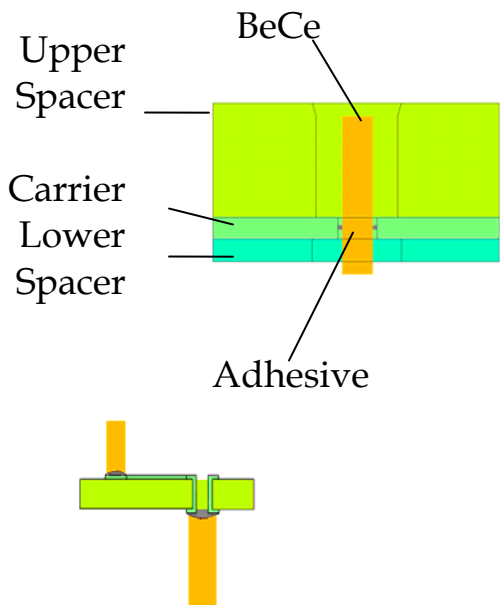


Fig. 5 BeCe fixed in Carrier
Fig. 6 Soldered BeCe

Fig.5 and 6 show BeCe retained by adhesive and by soldering respectively in the interposer. The spacer design is important in interposer construction. It serves two important functions, one for buckling prevention and another for over loading of BeCe prevention.

When drop in replacement is of interest interposer can be cut in the way that will fit the interposer into the connector casing without altering the form factor. Here self-assembly capability is important.

Connectors:

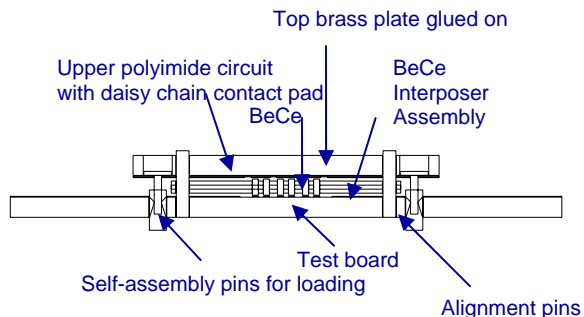


Fig. 7 Flex to Board connector

See for example, Fig.7 because most of the current connector is based on pin/receptacle contact that is capable of self-assembly. Fortunately, the contact force for BeCe is low so that pin/receptacle can be used for mechanical purpose only. A pair of pin/receptacle contacts can be used to apply contact force for up to 20 BeCe. If the array contains more BeCe, we can add pin/receptacle contacts proportionally.

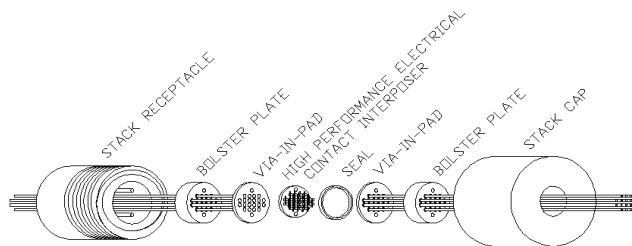


Fig. 8 Wire connector

We show as examples wire-to-wire connector (Fig.8) and flex-to-board connector (Fig.7). It should be noted that the same design could be applied to board-to-board, backplane, and other connectors.

In both designs, the interposer is the key component. Pin/receptacle contact applies the contact force in flex-to-board connector. The same can apply the contact force for wire-to-wire connector or in Fig.8; the contact force is applied by closing the two caps.

Summary:

BeCe connector has inherent tradeoffs between the mechanical, electrical, and reliability performance. We have described few connector styles which have excellent reliability performance and which can be engineered to simultaneously meet aggressive mechanical and electrical requirements. These interposers or connectors could be also used in package-to-board connections, test and burn-in sockets, board-to-board connections, and several other challenging connector applications where low resistance and inductance is a key to high frequency applications.

Reference:

1) Basic BeCe patents: US 7,040,902,
US 7,029,288, Chinese Patent,
ZL200480011283.4

2) Patents for application of BeCe and
interposer:

US 7,128,592, Wire-to-wire, flex-to-flex, wire
or flex-to board, sealed or un-sealed with
generic fine pitch electrical contact

US 7,029,289, same as above with BeCe as
the electrical contact

US 7,358,603, High density electronic
packages, soldered and wire bonded BeCe
and use for CSP and SIP