Industry Newsletter &
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GAISER TOOL COMPANY

• Inventors of the Ceramic Capillary •

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IC Angle Impact on Bondability

The impact of the Internal Chamfer Angle(ICA) on ball bond shape and integrity has long been known to the bond process engineers. The differences between a 90 degree ICA and a 120 degree ICA are clear when the ball size and shape are compared. The 90 degree ICA provides less squash or deformation on the finished bond as compared to the 120 degree ICA.

The push to control bonded ball size and shape to satisfy increased demands for Finer Pitch bonds has forced the use of steeper ICA (< 90 degrees). The disadvantage that comes with such steeper ICA is the negative impact they have on shear strength, intermetallic formation, and in many cases the potential for inducing subsurface damage to the bond pads.

The reason steeper angles tend to minimize ball bond deformation is because of the reduced compressive force applied perpendicular (Fy) over the Internal Chamfer (IC) surface. The smaller stress applied by this component (Fy) minimizes the amount of material being pushed out of the IC area therefore allowing the material to be easily extruded inwards to fill the IC cavity. At the same time that the compressive forces are reduced, another compressive force component (Fx) increases as the IC meets the face angle. This component is the one responsible for potential subsurface damage on the bond pads.

In order to illustrate the impact of the IC compressive forces, a 90º ICA was used in the following calculation.

Where:
SA = Surface Area for IC
F = Bond Force in grams
P = Pressure
$m = \sqrt{IC^2+h^2}$
$h = \tan\sigma * ((D-d)/2)$
$\sigma = ICA/2$
D = B or CD diameter
d = Hole diameter
IC = (D-d)/2

So **$SA = (Pi/2)*m*(D+d)$**

And **$P = F/SA$**

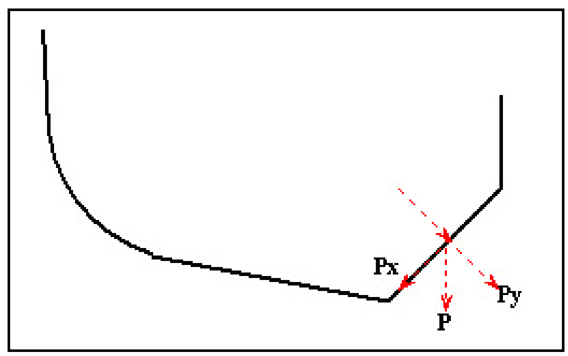
When σ = 90º/2 and D = 355.6µm
and d = 228.6µm

then SA = 2919.96µm^2

If F = 25 grams and SA = 2919.96µm^2

then P = 0.0086 gm/µm^2

To calculate the different pressure components the following diagram is used.



$Px = P*\cos\sigma$ and $Py = \sin\sigma$

So if P = 0.0086 gm/µm^2 and σ = 90º/2

Then
Px = 0.00608 gm/µm^2 and
Py = 0.00608 gm/µm^2

From P = F/SA then

Fx = Px*SA and
Fy = Py*SA

So,

Fx = 17.75 grams and
Fy = 17.75 grams

As the calcualtion shows the force components are in equilibrium when a 90 degree ICA is used. This equilibrium can be shifted either way to satisfy process demands, small consistent bonded size, or higher intermetallic formation but not both.

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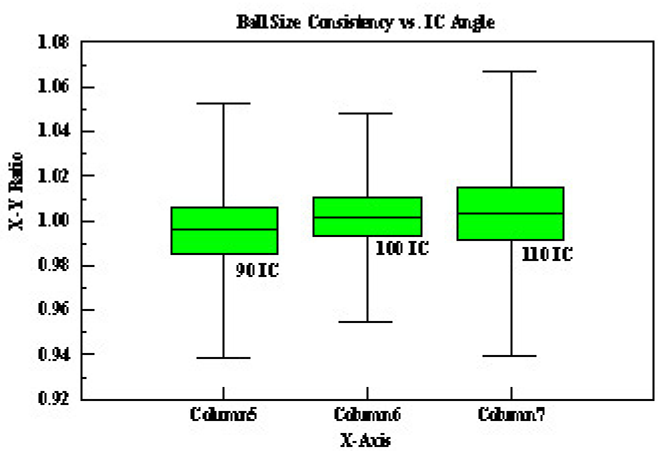
Small increments in the IC angle can provide the nessesary optimization for increased intermetallic formation (higher shear strength) without affecting bond shape considerably. An example of such optimization is GTC 100 degree ICA targeted to Fine Pitch applications with increased intermetallic formation and good bond deformation.

The graph below illustrates a ball size ratio (X/Y) comparison study between 90, 100, and 110 degree IC capillaries and intermetallic analysis.



Intermetallic Analysis

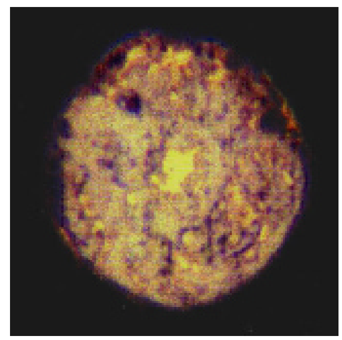
90º IC   100º IC   110º IC

If the same procedure is used to calculate the force components acting upon the IC surface of a 120º ICA, the Fy increases as the Fx decreases.

The values for an ICA = 120º are
Fy = 21.65 gram and
Fx = 12.49 gram

If we now calculate the values for an ICA = 70º then
Fy = 14.34 gram and
Fx =20.48 gram

From this last example it is obvious that the Fx is already approaching the original F value while the Fy (perpendicular to the surface of the IC) is dropping in value therefore less direct compression is applied over the surface of the ball bond. This will potentially result in minimum, if any, intermetallic growth at the center of the bonded ball as shown in the figure below.



ISO Announcement

Gaiser Tool Company is pleased to announce the achievement of ISO 9001:2000 Certification.
Effective date: May 20, 2005

ISO 9001:2000 CERTIFICATION Intertek

Certificate No.
US-3128


Intertek Systems Certification

Certificate of Registration

Gaiser Tool Company

ISO 9001:2000

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