Au/Au Bonding: Summary:

1. Thermo-compression bonding is typically gold/gold bonding. Heat is supplied from the top and bottom to soften the metal and surface burn off some of the oxides.
2. Force: It is safe to calculate force 50-75g/bump. Use more pressure for rougher substrate material.
3. Elevated standby temperature is to "saturate" the die and substrate to have less thermal drift during the heating and cooling process. It also decreases the processing time.
4. Ramp rates should match. In other words, die and substrate should not have a huge differential ramp rate. This is to minimize thermal differences and to match the CTE of the top/bottom material.
5. CCH Module ramps are intrinsically slower than the heating plate. It is OK to increase the standby temp of the CCH module to 180C or delay the start of the heating plate. The goal is to match ramp rates of die and substrate to reduce CTE mismatch.
6. The time at reflow needs to be only 10 seconds.

Process Settings:

Standby heat:	Top heat: 150C	Bottom heater: 150C	
Process heat:	Top heat: 330C		Time: 20 seconds
	Bottom heat:	320C	Time: 20 seconds
Force:	Bump count times 60 grams (102 grams per Newton)		

Au/Sn Bonding: Summary:

1. The Gold/Tin (Au/Sn) thermo-compression bonding process is typically deposited Gold/Tin or gold tin pre-form.
2. Force and heat from bottom and/or top in addition to forming gas (to clean oxides off of tin (Sn).
3. Forming gas is a mixture of hydrogen and nitrogen. Never use more than 5% hydrogen. Anything more than 5% is dangerous
4. Typical temperatures are anywhere between 310 through 340C with the reflow not lasting for any more than a few seconds.
5. It is important to have "fast" ramp rates to minimize the oxidation.
6. Top heat is not always used, but if it is used the CCH Module cannot match the bottom heater speeds. A few ways of coping with the CCH Module's slower ramp rate is to have a CCH module standby temperature of 180C or delay the start of the heating plate.
7. It is desirable to use an unheated tool with Laser Bars to further reduce oxidation.
8. Force: Typical force for Laser Bar bonding is 4N or less. Any time you see solder balls, reduce the force (also verify that the solder is not overly thick).
9. Heating Plate should ramp as quickly as possible. Most of heat for bonding will be from the Heating plate because the substrate is normally a larger thermal mass and the die is a very small thermal mass. Maximizing ramp rate is essential for Au/Sn bonding because of oxides.
10. Typical solder thickness is 3-6micron but mostly in the 3-4micron range. Anything above 4micron could result in solder balls. Keeping vacuum turned "ON" during the bond is normal. This keeps the die aligned to the substrate during the process. Au/Sn is a "slippery" solder. Holding the die with vacuum helps with post bond accuracy!
11. Flow rate for the process gas module is adjustable. It is safe to use 3-5liters/minute. Anything more and be sure that you are not cooling down the heaters/material with too much flow.

Thermo Sonic Bonding: Summary:

1. ALL Thermo Sonic process uses the heating plate to heat substrate up to approx. 150C to 180C to saturate it. Using Ultra-Sonic Energy is similar to rubbing your hands together to generate heat.
2. The start time of the Ultrasonic transducer should be near the end of the heating cycle. This ensures proper heat saturation of the substrate. Force is also used from the top and it is safe to use the calculation of 50 to 75g/bump.
3. After approx. 100 I/O, it is difficult to balance the parameters for T/S Bonding.
    a. More bumps = more energy.
    b. More energy = more force
        c. Too much energy OR force result into the die collet breaking the vacuum and the collet scrubbing on the top of the die....not at the gold/gold interface!
4. Not enough energy or force result in a bond that is not sufficient. (This is NOT a Finetech (Machine) issue. This is truly a process issue.
5. Using a mechanical collet (Inverse Pyramid) could result in chip or fractured die.
6. Thermo sonic accuracy is 0-8um.

Indium/Indium bonding: Summary:

There are two ways to bond Indium "bumps":

1. Use heat (top and bottom) with force - This process is a true thermo-compression bond. The challenges are:
    a. Indium is soft. Having a fixture that allows you to place the bumps down is not easily achievable. Using a picture frame fixture design allows the user to place the die onto the picture frame, which has an opening for the indium bumps. This way, nothing makes contact w/ the bumps. Using this method allows you to pick and place the die w/o flattening the bumps on the die. Often times, the die can have up to 20,000 bumps.
    b. Oxidation is very common when bonding Indium. Using Flux is one method of helping the oxidized solder to reflow. Another method is using Formic Acid.
2. Cold bond with a lot of force - another way of bonding Indium is a "Cold" bond. This process is sometimes used for devices that are heat sensitive or cannot use a flux agent for proper wetting. In this case, presentation of the die is still using a picture frame concept. Alignment/placement are the same. High force is used to fuse the solder to substrate. We can get a calculation from Germany regarding the surface area and how much force is require per mm squared. No formic acid is used for this process. This process is mostly used for sensors.

    NOTES -
    1. Vacuum to the tool should be turned off when heating the die. When vacuum is turned on, this could create a cold spot and therefore, could influence how the overall bond is formed.
    2. Formic Acid requires house exhaust
    3. This is a typical process for Indium bonding w/ heated tool and substrate. If CCH module tool is not heated, the goal should be to raise the temp quickly and cool down quickly because of oxides.

<u>Deposited Indium Bonding Summary:</u>

Deposited Indium is the same as using Indium pre-forms.

1. Using heat (top and bottom) with force. This process is a true thermo-compression bond. There are some challenges though with this process to be aware of.
   a. Like Indium bumps. if the solder is deposited or in pre-form, it will oxidize. For laser diode process, it is common to bond within 4 hours of the solder being deposited to eliminate oxidation. After 4 hours, the solder will oxidize. Using Formic Acid is a common method for eliminating the oxide layer on the Indium. This is a very common method of bonding Laser Diodes, bars, power lasers. And like Au/Sn bonding for laser devices, often times using an unheated tool is preferable. This eliminates one variable all together (CCH Module temperature). And it allows you to ramp the heating plate up and down quickly.
   b. Pre-forms are a pain to use. They have to be cut and placed onto the substrate for bonding. There is no easy way to keep the pre-form in the same place when using tweezers to place it on the substrate. But this is unimportant. There will be oxidation when using pre-forms. No true way around it.
2. Force: Typical force for Laser Bar bonding is 4N or less. Any time you see solder balls = reduce the force.

   NOTES -
   1. Vacuum to the tool should be turned off when heating the die. When vacuum is turned on, this could create a cold spot and therefore, could influence how the overall bond is formed.
   2. Formic Acid requires house exhaust
   3. This is a typical process for Indium bonding w/o heated tool.