Plastics Assembly

The Heat Stake Advantage

By Gary Sullivan and Lance Crawford - SAS and Thermal Press Int'l, Inc.

Over the last 10 years, advancements in solid modeling technologies and subsequent changes in the injection molding industry have created the need for more complex and diverse assembly solutions. Due to the more complex and stringent requirements for strength, tightness, and aesthetic characteristics in the electronic, medical, and automotive component assembly, the need for a non-violent or degrading method for plastic assembly has increased. There are a multitude of technologies and companies that produce machines for plastic assembly. A few of these plastic assembly technologies include infrared, laser, hot air/cold upset, and thermal impulse, as well as the welding technologies - ultrasonic, vibration, hot plate, RF, and spin. Many of these technologies have limitations that can dramatically affect the assembly process such as material selection, filler material (additives used), cycle time, tooling costs, and particulate generation (debris related to the volatile nature of the assembly process used).

Assembly challenges such as attaching components to populated printed circuit boards or complex plastic parts can be overcome by using the heat staking assembly process. The process of applying heat and pressure to stake, swage, or seal the post(s), tab(s), wall(s) or an area of one or more plastic parts to other part(s) which could be pcb(s), metal frame(s), or other plastic part(s), is commonly referred to as heat staking. There are several specific processes within the heat staking family. The accurate description for the heat staking process is using precise heat and pressure to reform a post or boss molded into a plastic part to retain or attach the plastic part to another component or part, such as a pcb, metal frame, etc. Heat swaging is a similar process to heat staking, but it involves rolling or reforming a wall (typically a perimeter) of a plastic part to retain another part or component. Heat insertion typically refers to the retaining of a threaded insert into a molded hollow boss of a plastic part. Heat sealing is another process that uses heat and pressure to seal or adhere an area of one plastic part or film to another part(s). Heat sealing is also an easy and consistent process used to apply heat seal connectors to PCBs or LCDs in many consumer electronic devices.

Not only are heat staking, swaging, and sealing the preferred methods for consumer electronic devices, but they also are the assembly method of choice for the following applications: multi-level staking or insertion projects; staking multiple threaded inserts at one time; applying heat seal connectors to an LCD/PCB; and swaging around the perimeter of a part for retention purposes. Damage to components and cold solder joints on PCBs caused by ultrasonic welding make heat staking the only viable staking solution for attaching a PCB into a plastic housing. Heat staking typically out performs its competition in cost, repeatability, strength, quality, reliability, and even throughput.

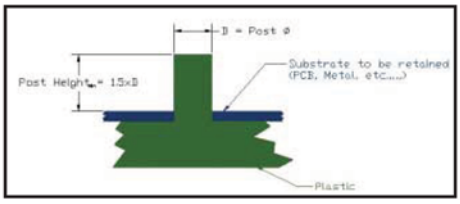
The heat staking process typically requires the temperature to be high enough to reset the plastics' memory, but not so high as to melt the plastic. Most thermoplastics have a fairly wide operating temperature window when assembled with a heat staking method. Higher pull strengths are typically achieved when the heat staking process is used for staking, swaging, and insertion applications.

Most processes that require melting of the plastic during the assembly process often create particulate or debris. This debris is an unacceptable side effect in most medical and consumer electronics applications. Although a lower temperature is used during the heat staking process, it is offset by the increased amount of force required to deflect the material without damaging the plastic.

With the heat staking method of assembly, there is an inverse relationship between the temperature and the force required to achieve an optimum completed stake, swage, or insertion. When optimizing the parameters for a specific plastic substrate, if the temperature is lowered then the force required must increase. To overcome the rebound of some thermoplastics or part design characteristics, optional post cooling technologies can be implemented.

Post cooling is the process of applying cold air towards the tip(s) of the thermal probe(s) or thermal tooling during the end of the staking, swaging, or insertion process. This lowers the temperature of the tooling and the plastic, while still held under the pressure of the thermal tool(s), which now act as a clamping mechanism.

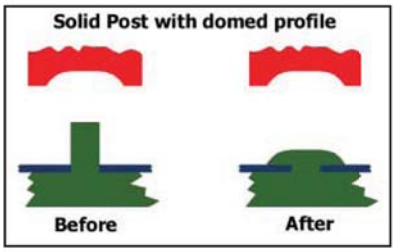
The heat staking process has very basic design standards that are recognized throughout the plastic assembly industry. When these design standards are followed the heat staking process produces strong, consistent, aesthetically pleasing assembled parts. The heat staking post design standards are described as follows:



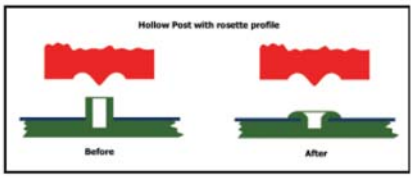
The height of the post, or portion to be staked, should be 1 - 2-$^1/_2$ times the diameter of the post above the surface. Typically, 1-$^1/_2$ times the diameter of the post will work for most applications. Post head geometry can vary, depending on the application requirements.

Posts can be round, square, cross-shaped, or hollow bosses. Different post designs can be selected for specific characteristics or aesthetic requirements. Round and square posts are the most commonly used, due to the ease in design and implementation into an existing or new mold cavity. Cross-shaped posts are typically used when design constraints due to wall thickness, overall post height, or possible sink marks on the opposing side of the part dictate the need for an alternate design concept.

Most heat stake posts can be staked adequately with a flat tipped thermal probe. Sometimes when higher break strengths or better aesthetics are required, a dome shaped profile can be cut into the thermal probe. The dome shaped profile will have to be accurately engineered, so that the minimum volume of the plastic to be staked can fit inside of the dome-shaped profile heat-staking tip. If the dome-shaped design is done correctly, no flash will be created around the perimeter of the finished heat stakes. Dome-shaped heat stakes require the greatest amount of force compared to the other standard staking profiles.



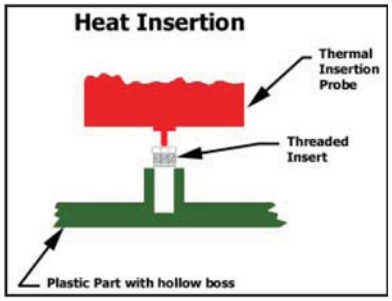
Hollow boss posts are typically used when high retention is required. Hollow bosses are also used for larger heat staking post applications. Typically, hollow bosses are not smaller than $^{3}/_{32}$" in diameter. A hollow boss post heat staked with a rosette shaped profile can create a substantially tighter and stronger heat staked assembly, while also producing one of the most aesthetically pleasing finishes. A rosette profile is a curved hollow ring, similar in shape to a rivet. A rosette heat stake gets its strength from how the profile in the tip rolls a large amount of material outbound around the perimeter of the hollow boss, creating a large contact surface area. The alignment for the thermal probes performing the rosette heat staking process requires greater accuracy than with flat tipped thermal probes.



A knurled profile on the staking tip is used in high volume operations where accuracy and aesthetics are not limiting factors. A knurled tip or surface can produce a tight bond very quickly.

Heat staking can be performed inside of counterbores and countersinks to keep the material below the surface, if needed. Heat staking into counterbores is relatively straight forward using a flat or dome-shaped staking probe, while heat staking into countersinks requires that the design be accurate, so the volume of the staking post will fill the countersink cavity.

The heat staking of threaded inserts requires a different style thermal probe(s) than that which is used for a standard heat staking application. Typically, temperatures are higher for insertion applications due to the thermal migration through the insert prior to contacting the plastic part.



De-gating or un-staking of components using the heat staking process is not only fast, but can be done with very little particulate, a problem typically found with ultrasonics. As with staking, melt temperatures are not required. De-gating probes are similar to staking probes, but have a pointed tip to help move the existing heat stakes away. ■

Gary Sullivan was the National Sales Manager for Specialized Assembly Systems, LLC. Lance Crawford is the Vice President of Sales for Thermal Press International, Inc. For more information on plastic assembly tecnologies, techniques, and equipment, please contact Lance Crawford at (925) 454-9800 or by email: lcrawford@thermalpress.com.