Crimping Versus Swaging

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This article describes the difference between **crimping** processes and **swaging** processes, as the terms are typically used in medical device manufacturing, where the workpieces are usually round. Most of this description also applies to general industrial use of the terms.

Marker bands (ductile) and structural bands may be processed by crimping or by swaging. Swaging is used when it's important that the band is round and smooth after the process. Balloon-Expandable (ductile) and Self-Expanding Stents (superelastic) are both often processed by crimping, and almost never processed by swaging.

The terms "crimping" and "swaging" both usually describe radial compression processes that deform and shape roundish objects, reducing their diameter. Therefore, the terms are sometimes confused and sometimes used interchangeably.

The most important distinction is that, **in crimping, the compression force is applied once** (or at most a few times), while **in swaging the force is applied many times** at high frequency. When swaging a radiopaque marker on a catheter, the force may typically be applied about 1000 times. In swaging, the product is usually moved slowly into a tapered die while the die closes and opens rapidly. The die is also usually rotating. For crimping thin-walled workpieces, the rotation of the die is necessary to let the workpiece compress stably without buckling.

	Crimping	Swaging
Force Cycles	One "hit"; the force rises and falls once	Many "hits"; the force rises and falls repeatedly at a high frequency
Deformation	The workpiece is deformed significantly by one hit. The process may operate in the elastic or the plastic range of the material.	The workpiece undergoes minute deformations by each hit. The materials are usually ductile; the useful deformation is in the plastic range of the material.
Solid, Thin-Walled Workpieces	Workpieces with solid, thin walls do not change perimeter, but rather take the shape of the die cavity (i.e. round to polygonal) and are prone to buckling	With rotary swaging, workpieces with solid, thin walls can remain very round even when the die cavity is not perfectly round, and can be significantly strained in the hoop direction without buckling
Solid, Thick-Walled Workpieces	Workpieces with solid, thick walls can be reduced without buckling, but will take the shape of the die cavity – often non-round	Workpieces with solid, thick walls can remain very round even when the die cavity is not perfectly round, and can be significantly reduced in diameter.
Balloon-Expandable (Ductile) Stents	Stents, or workpieces designed to strain in the hoop direction, can be significantly reduced in perimeter without buckling, and will take some non-round shape of the die cavity	Stents are not typically processed by swaging
Self-Expanding (Superelastic) Stents	Stents, or workpieces designed to strain in the hoop direction, can be significantly reduced in perimeter without buckling, and will take some non-round shape of the die cavity	Stents are not typically processed by swaging

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This picture show how thin-walled tubes react to crimping and swaging.