

Nitinol Wire Forming and Manipulation for Custom Components:

MEETING CUSTOMER REQUIREMENTS

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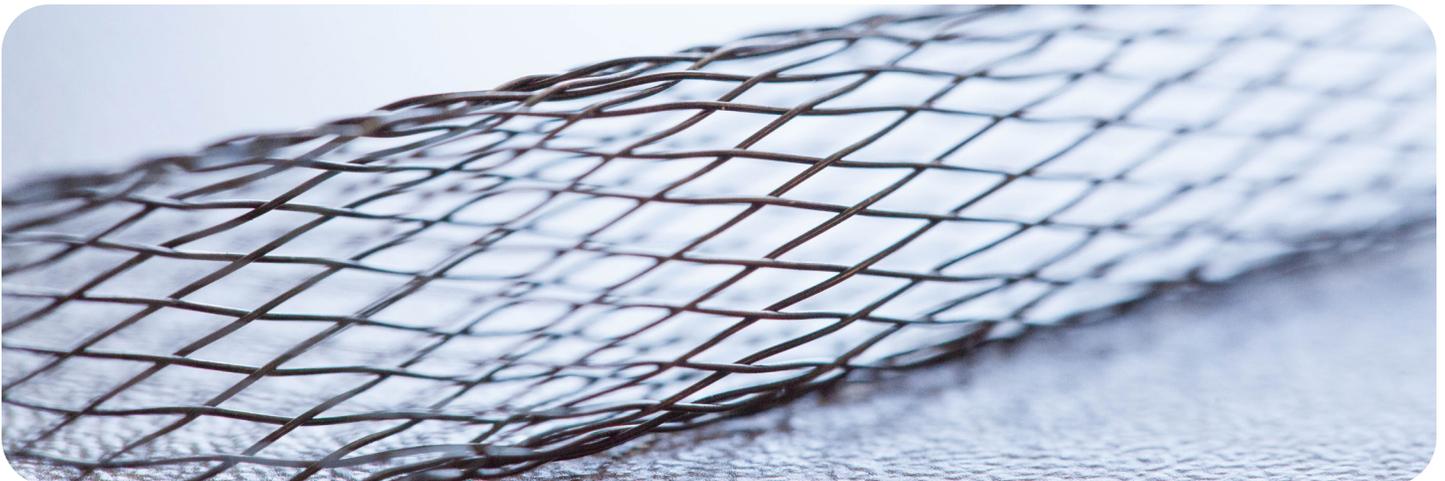
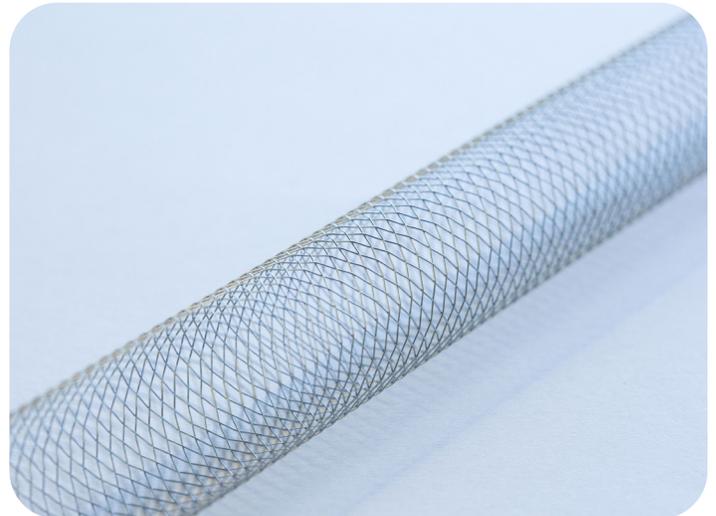
Meeting Customer Requirements

INTRODUCTION

With its shape memory properties, nitinol wire is a highly suitable material for a range of medical applications. Given its exceptional mechanical and thermal properties, the demand for nitinol products is on the rise. This paper delves into the process of forming and manipulating nitinol wire to create customized components.

WHAT IS NITINOL?

Nitinol wire is a shape memory alloy made from a combination of nickel and titanium. Nitinol wire has two distinctive properties, namely superelasticity and shape memory. Superelasticity refers to the ability of nitinol wire to recover its original shape after being deformed, while shape memory refers to its ability to “remember” its original shape and recover it upon heating. These properties, along with biocompatibility, make nitinol particularly useful in medical applications, where precise and consistent shape recovery is essential and designs must be flexible.



NITINOL WIRE FORMING

The nitinol wire forming process involves various techniques such as drawing, rolling, extrusion, and swaging. These techniques allow for the production of nitinol with different diameters and shapes to meet specific customer requirements.

Different Forming Techniques

DRAWING

Drawing is the most commonly used technique to produce wire with a smaller diameter and involves pulling nitinol wire through a series of dies. The nitinol wire is heated above its transformation temperature, which makes it easier to deform. The process of drawing is repeated several times until the nitinol wire reaches the desired diameter. The advantage of drawing is that it produces nitinol wire with a high degree of dimensional accuracy and consistency.

ROLLING

Rolling is another nitinol wire forming technique that involves passing nitinol wire through a series of rollers to reduce its diameter. The nitinol wire is heated above its transformation temperature to make it more malleable. The advantage of rolling is that it can produce nitinol wire with a wide range of diameters and lengths.

EXTRUSION

Extrusion is a technique that involves forcing nitinol wire through a die to produce a desired cross-sectional shape. The nitinol wire is heated above its transformation temperature and pushed through the die using a hydraulic press. This can produce nitinol wire with complex shapes, including tubes and rods.

SWAGING

Swaging is another technique that involves compressing nitinol wire between two dies to reduce its diameter. The nitinol wire is again heated above its transformation temperature to make it more malleable. Swagging allows nitinol wire with a high degree of dimensional accuracy and consistency to be produced.

Factors that Affect Wire Forming

TEMPERATURE

Nitinol wire undergoes a phase transformation from its martensitic to austenitic phase when heated above its transition temperature. This transition temperature is dependent on the composition of the nitinol wire, with higher nickel content resulting in a higher transition temperature. The heating temperature must be accurately controlled to ensure that the nitinol wire is heated to its desired transition temperature. If the temperature is too high or too low, it can lead to the formation of defects in the nitinol wire, resulting in a lower quality product.

STRAIN RATE

Nitinol wire undergoes significant plastic deformation during the forming process, and the strain rate determines the degree of deformation. A high strain rate leads to a greater degree of plastic deformation and can result in higher residual stress in the nitinol wire. Therefore, it is essential to control the strain rate during nitinol wire forming to ensure that the nitinol wire meets the desired mechanical properties.

MATERIAL PURITY

Impurities in the nitinol wire can affect its mechanical and thermal properties, resulting in a lower quality product. The use of high-purity nitinol wire in the forming process is essential to ensure that the final product meets desired specifications.

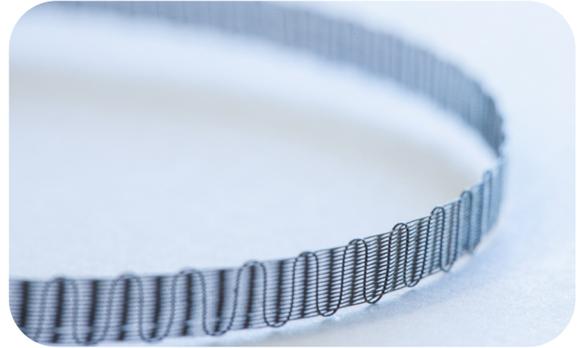
NITINOL WIRE MANIPULATION

Nitinol wire manipulation is the process of shaping, cutting, or joining nitinol wire. Temperature, force, and speed are significant factors affecting wire manipulation. The temperature affects the ductility and shape recovery of the nitinol wire, while the force and speed affect the shape and surface quality of the wire. Depending on the desired shape and properties of the nitinol product, manipulation techniques include bending, coiling, and cutting.

Different Manipulation Techniques

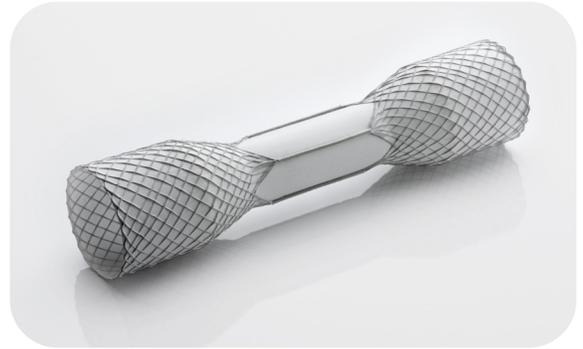
BENDING

Bending is a nitinol wire manipulation technique that involves deforming the nitinol wire into a curved shape. Bending can be performed using a variety of tools, including pliers, benders, or a bending machine. Bending can produce nitinol wire products with a range of curvatures and shapes.



COILING

Coiling is another technique that involves wrapping the nitinol wire around a mandrel or a cylindrical object to create a coil. The diameter of the mandrel determines the diameter of the coil, so products can be made in a wide range of diameters and lengths.



CUTTING

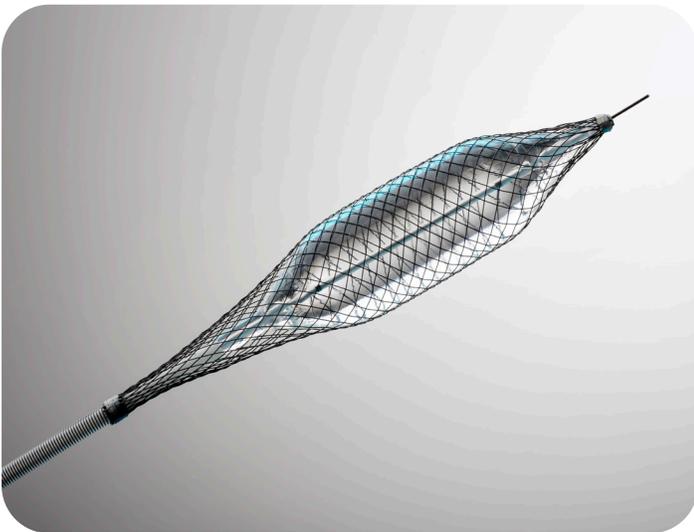
Nitinol can also be cut into precise lengths using a variety of tools, like wire cutters or a cutting machine.



CUSTOMER REQUIREMENTS

The shape, size, and properties of nitinol must meet the industry's and customer's specific requirements. In the medical industry, nitinol products are used in the production of devices such as stents, snares, baskets, graspers, extractors, and more. Medical device manufacturers have specific requirements for the mechanical and thermal properties of nitinol wire products, which influences the nitinol wire forming and manipulation used in the production process.

Device manufacturers require nitinol wire products with specific properties, such as biocompatibility, corrosion resistance, and superelasticity. Components with precise dimensions, tolerances, and surface finishes are critical to ensure that they function correctly and safely.



QUALITY CONTROL

Poor quality products can result in component failure, which can have severe consequences in the medical industry. Quality control measures are vital to ensuring that nitinol components meet strict regulatory and industry standards. This helps minimize the risk of defects, improves product reliability, ensures production consistency, and ultimately meets customer needs.

Important Quality Control Measures

TENSILE TESTING

Tensile testing evaluates the mechanical properties of nitinol products, such as strength, ductility, and elasticity. In this test, a sample of nitinol wire is stretched to its breaking point, and the load and deformation are measured to determine the wire's properties.

SURFACE ANALYSIS

A surface analysis is done to evaluate the surface finish and cleanliness of nitinol wire products. Surface analysis techniques, such as microscopy, X-ray photoelectron spectroscopy (XPS), and scanning electron microscopy (SEM), are used to examine the composition of the nitinol.

DIMENSIONAL MEASUREMENTS

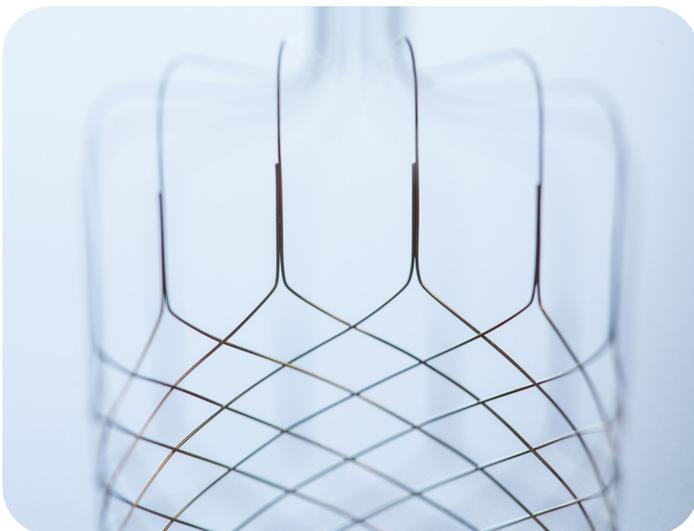
Dimensional measurements ensure that nitinol wire products meet customer requirements for size, shape, and tolerances. Dimensional measurements can be performed using optical or laser metrology, micrometers, or coordinate measuring machines (CMMs).

CHEMICAL ANALYSIS

Chemical analysis techniques, such as inductively coupled plasma mass spectrometry (ICP-MS), are used to measure the elemental composition of nitinol wire products.

HEAT TREATMENT VERIFICATION

Nitinol wire products often undergo heat treatment processes, and this process ensures that they have been correctly treated. This can be achieved through differential scanning calorimetry (DSC) and X-ray diffraction (XRD).



CONCLUSION

Nitinol wire forming and manipulation are essential processes in the production of nitinol products. The choice of technique depends on the desired shape and properties as determined by the device manufacturer, and frequent inspection is important to ensure that requirements are met and quality is achieved.

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