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Hot Application
Wire Stripping

THIS ISSUE

The Challenge

Wires and cables are the primary means to carry current throughout electronic devices. To protect against short circuits and maintain the integrity of the wire, they are often encapsulated in a protective insulation.

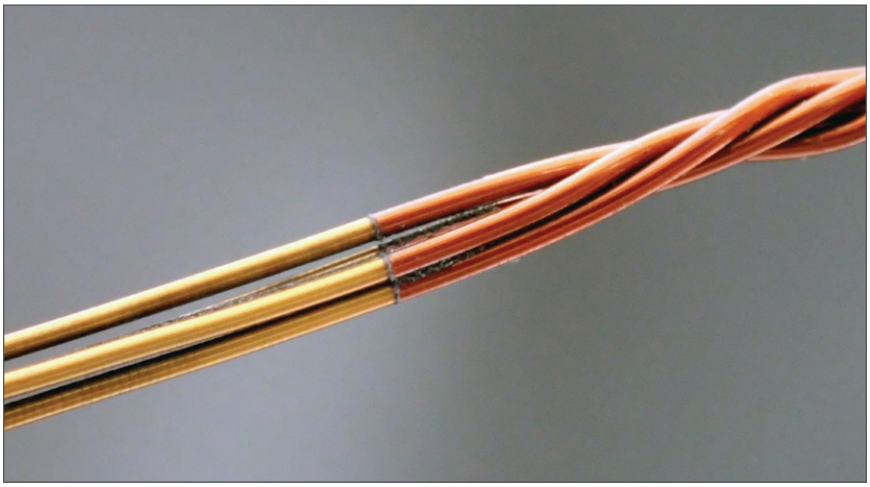
Typically, the wire is cut to length and then the coating/insulation is removed at the ends to provide the electrical contact.

For heavier gauge wires, the sheathing can often be removed via mechanical processes - even in automation. As the wire gauge becomes lighter, however, alternative stripping solutions need to be utilized.

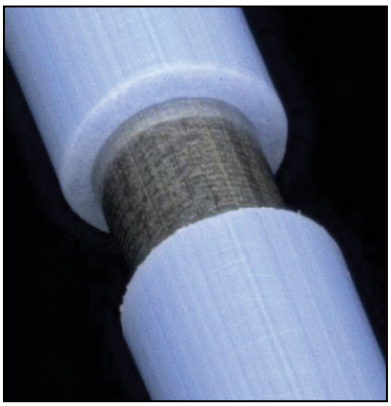
Solution:

Wires need to be stripped of their insulation quickly and cleanly, without damage to the conductor. Lasers have proven to be a successful technology to selectively remove the coating in the desired locations.

The type of laser that is optimal for a specific part is dependent on the coating material, conductor material, and wire gauge. Lasers are ideal for integration into automated assembly lines, and they can be programmed to remove insulation at any location on the part without causing damage to the conductor. It is also possible to process multiple wires at one time.



Insulated Wire



PEBAX®[1] on stainless steel tube

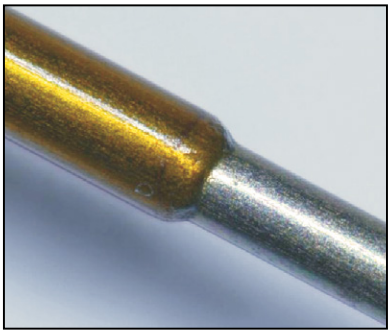
Wire is, most typically, a round strand of metal used to carry electrical currents in applications across multiple industries. It is less common to find "flat" or shaped wires. These individual strands are often placed together to make a multi-element cable.

Most wires are insulated in order to:

- Help prevent short circuits
- Protect conductors from water and corrosion
- Provide a smooth, slippery surface for comfort (medical applications)
- Reduce power leakage, increasing electrical efficiency

The type of insulation used is largely determined by the purpose of the wire. Will it be exposed to high heat or intense cold? Will it be implanted in a human body? Is weight an issue? Common insulators include PVC and various enamels like THEIC, PAI, PVF, PDA, KAPTON®[2], ETFE, PFA and FEP.

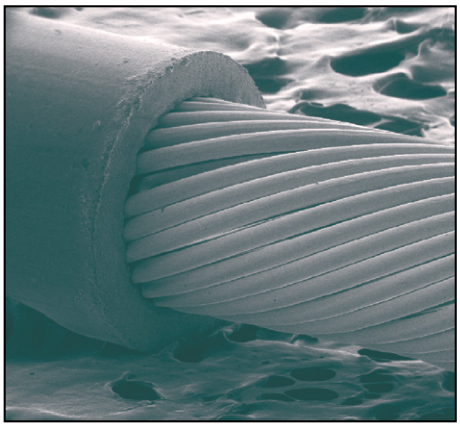
Conventional Wire Stripping



While insulation is beneficial for the reasons described above, it can limit current carrying capacity and affect downstream manufacturing processes like welding, soldering, or brazing. Manufacturers need to strip the insulation from the wire in order to provide electrical contact points. The trick is to remove the insulation cleanly and

[1]PEBAX is the trademark of Arkema France Corporation [2]KAPTON is the trademark of Dupont Electronics

precisely without overheating and damaging the conductor. A common manual process for removing insulation entails dipping each wire individually into a solvent, and then manually scraping away any remaining coating material deposits with a sharp blade. Other conventional wire stripping techniques include abrasive and thermal methods which are fairly slow, lack precision and quality, carry high probability of damage to the conductor, and are almost impossible to carry out on very fine gauge wires such as those used in medical applications. In addition, these methods require frequent cleaning, maintenance and adjustment, and they also risk damaging the conductor.



Laser Wire Stripping

Laser wire stripping overcomes the challenges encountered in manually removing the coating. This non-contact approach keeps the conductive material and shield intact, virtually eliminating weak spots for breakage or conductor resistance. Since the laser imparts no physical force on the wire during the process, delicate wires, with diameters as small as 50 microns, can be stripped. Material is removed by directing a focused beam (around 25 microns in diameter) at the part and then steering the beam in a set path, enabling highly tailored removal.

A Case Study

A good example comes from a large medical device company that recently transitioned from a manual to a laser process for producing stainless steel guidewires used in intravascular interventional devices. The wire, which has a diameter of about 100 microns (similar to that of a human hair) is coated with an organic material that makes it compatible for use in humans. This organic coating must be stripped away from the microscopic metal core wire, however, to enable connection to the guidewire's distal end.

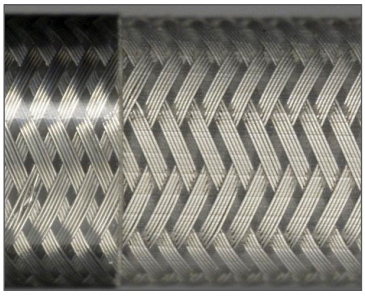
	Process	Comments
Existing Process: Manual Wire Stripping	The company's legacy wire stripping solution was to dip the wires in a chemical bath, and then manually scrape away remaining residue.	• Slow: approximately 8 minutes per wire • Requires the use of chemicals • Requires the use of sharp objects
New Process: Laser Wire Stripping	The laser process consistently and precisely strips away the organic material coating from the component's metal core wire, enabling other subsequent downstream assembly operations.	• Takes only seconds to complete • Throughput increased to 250% vs the manual process • Higher yield and quality achieved • Eliminated usage and handling of chemicals • Semi-automated laser stripping ensured process control, improved worker safety, and supported ISO14001 sustainability program

Selecting a Laser for Wire Stripping

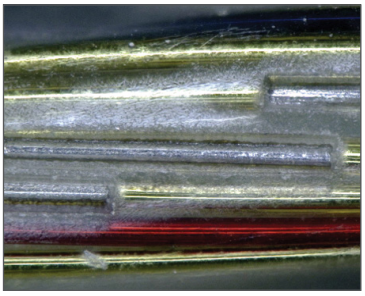
A number of different lasers may be used for wire stripping, depending on the particular wire diameter, insulation material, and feature requirements. The table below shows the most commonly used lasers.

Laser type	Process attributes
Sealed CO_2	• Laser radiation absorbed well by all polymers • Laser radiation absorbed poorly by metals • Wide process window • Suitable for insulation removal for heavier gauge wire • Not suitable for fine wires where heat from process may result in damages
Nanosecond fiber and Nd:YVO_4 - IR, green, and UV wavelengths	• Laser radiation absorbed well by most, but not all, polymers • Ablative material removal process limits heat input • Well defined edges • Potential for minor burrs and melting of metals • Suitable for enamel removal
Picosecond and femtosecond - IR, green, and UV wavelengths	• Best quality removal and edge definition • Cold processing with no heat input • Ability to remove individual layers of coextruded polymers • Precision removal often leads to a slower process • Suitable for insulation and enamel removal

Conventional nanosecond IR, green, and UV lasers can provide suitable quality for many applications at a moderate price point. However, when optimal quality and minimal heat input are needed, it is best to consider ultrashort pulse picosecond and femtosecond lasers. Ultrashort pulse lasers, which are also offered in IR, green, and UV wavelengths, produce pulses that are so short that effectively no heat is conducted from the processing area into the surrounding material. However, these top-quality results can come at a considerable price.



Polyurethane on tantalum braid



30 µm x 50 µm ablation region

Selective ablation

Benefits of Laser Wire Stripping

- Able to process a wide variety of insulation types
- Process multiple wires simultaneously
- Strip a variety of wire sizes and forms including very small wires less than 50 microns in diameter
- Remove insulation in various programmable strip patterns at any point on the wire including end-strip, windows, and angled cuts