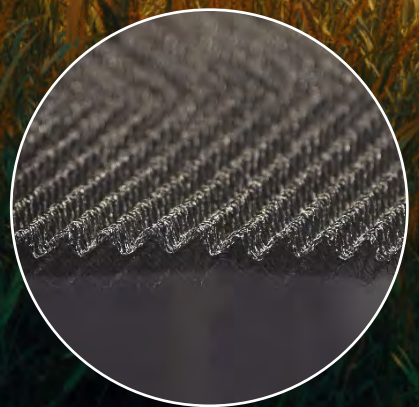


Leading the world in Knitted Mesh for Hydrogen Production



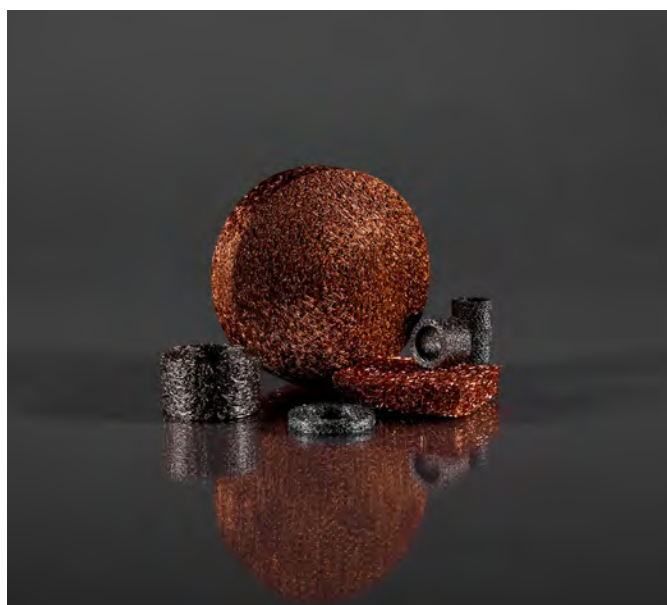
KnitMesh[®]
Technologies

Protecting People, Property and our Planet



An introduction to KnitMesh Hydrogen

Welcome to KnitMesh Technologies, the acclaimed technical leader in designing, developing and manufacturing innovative knitted wire mesh solutions.



KnitMesh Technologies works with customers across all industrial and commercial sectors to solve challenging technical problems and support their product development initiatives to deliver reduced costs and improved process efficiencies.

With state-of-the-art manufacturing facilities in the UK and India, KnitMesh specialises in helping to provide bespoke solutions in some of the world's most demanding process environments.

KnitMesh Technologies is committed to continually improving the quality and functionality of their products and services, ensuring that customers benefit from superior products and demonstratable value-for-money. These efforts are complemented by a highly-skilled engineering team that develops the most advanced manufacturing processes to meet customers' stringent quality, service and cost standards.

About our knitted mesh

Any material available as a wire, thread or yarn can be processed into knitted mesh. Typical raw materials are synthetic yarns and metallic wires, including stainless steel and more specialist products including nickel and titanium or a variety of coated metals.

In its most basic form wire is processed into a knitted mesh structure comprising a series of interlocking loops. Each individual loop acts as a small, highly resilient spring that retains

its strength and elasticity even after processing into its final form. This renders the mesh ideal for use in arduous process applications that require these unique features in a strong, durable and cost-effective but lightweight structure.

KnitMesh Technologies has developed a number of proprietary welding processes that yield structural porous media solutions, in a range of forms - from highly flexible to rigid that are supplied to customer-specific requirements.

Main properties:



Flexible & Malleable



Energy Absorbing



Variable Porosity



Harsh Environments



High Resilience



High Strength



Encapsulates & Protects



EMC & RFI Shielding



Cost Efficient



Electrically Conductive



Environmentally Friendly



Material Versatility



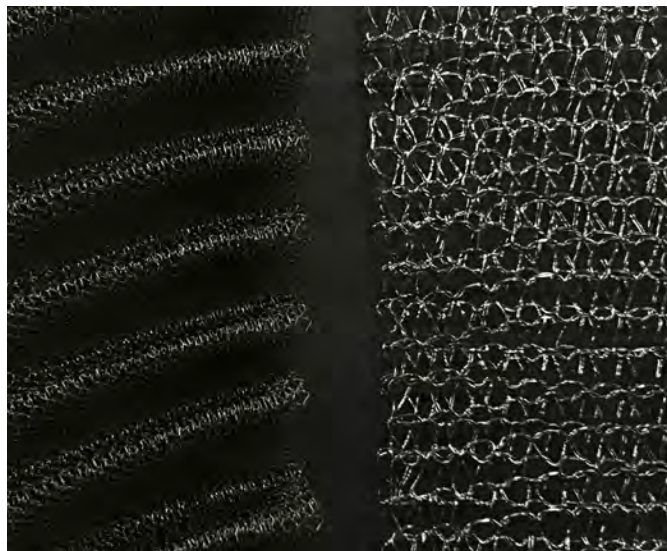
High Surface Area

Innovations for hydrogen production

Due to its highly compressible, porous, conductive and resilient elastic properties, companies utilise knitted mesh for various electrochemical applications, including chlor-alkali production, fuel cells, power-to-gas and water electrolysis.

KnitMesh Technologies manufacture bespoke knitted mesh solutions for use in Polymer Electrolyte or Proton-Exchange Membranes (PEM), Ion Exchange Membranes (IEM), and also in the extremely harsh conditions associated with Alkaline Zero-Gap Electrolyser applications.

Knitted mesh is available in an infinite range of widths and a variety of materials, including transition metals such as nickel and titanium. This flexible and robust material reduces cell voltage losses and improves process efficiencies.



The knitted mesh is highly corrosion resistant and withstands demanding operating temperatures, pressures and caustic electrolyte solutions (typically potassium hydroxide).

Engineers specify knitted mesh in compressed or crimped, conductive and compressible fabric form for various electrochemical applications, including chlor-alkali production, fuel cells, power-to-gas and water electrolysis. In flat sheet form, knitted mesh provides a smooth, high surface area, conductive layer that enhances PEM protection.

Knitted mesh optimises electrical and pressure contact between cells, divider stacker plates, membranes and diaphragms in electrolysis cell stacks and modular cell cartridges.

This world-leading material is manufactured from a web of interlocking loops (typically using 0.05 to 0.35mm diameter wire) and is ideal for a variety of applications in the hydrogen production process.

Mesh-Jointing Technology

KnitMesh Technologies has developed an innovative Mesh-Jointing Technology that welds knitted mesh to every contact point on metal plates. These advanced welding processes produce an homogenous joint that reduces internal cell resistance whilst significantly improving electrical conductivity.

Features & Benefits

- **Uniform compressibility ('spring force'):** ensures an even force is applied to the electrode or membrane
- **Highly elastic:** facilitating reduced cell voltage and energy use, ensuring improved overall process efficiencies and significant cost reductions
- **High resilience:** compression ratios of >50%, with no plastic deformation, facilitates the use of knitted mesh in a wide range of harsh operating environments
- **Electrical properties:** optional welding to adjacent components, or welding within the mesh structure ensures reduced electrical resistance
- **Scalable:** superior gap control from <1mm and up to virtually any width required in cell stacking applications
- **High strength:** zero wire breakages eliminates the risk of puncture to membranes in PEM applications
- **Open structure:** allows the hydrogen gas produced to rise up to the top of the cell for easy collection
- **Fail-safe:** cut-ends (along only 2 sides) can be enclosed to protect the membrane
- **Versatile:** the finished mesh can be used as the current carrier, spacer or electrode
- **Bespoke:** available in any metal, including nickel, titanium and plated wires



Electrical Resistance

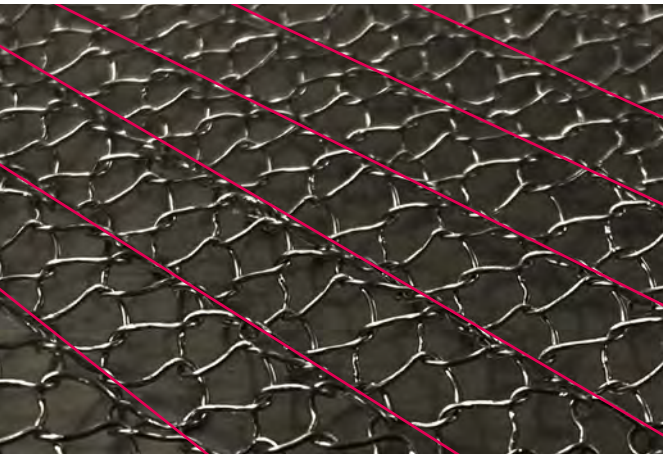
Electrical resistance within electrolyzers reduces their efficiency and increases operating costs. In conventional designs, the knitted mesh is in direct contact with the electrodes, bipolar plates and other additional components.

KnitMesh Technologies work closely with customers to develop the unique knitted mesh solutions that integrate the required application-specific properties for their individual needs.

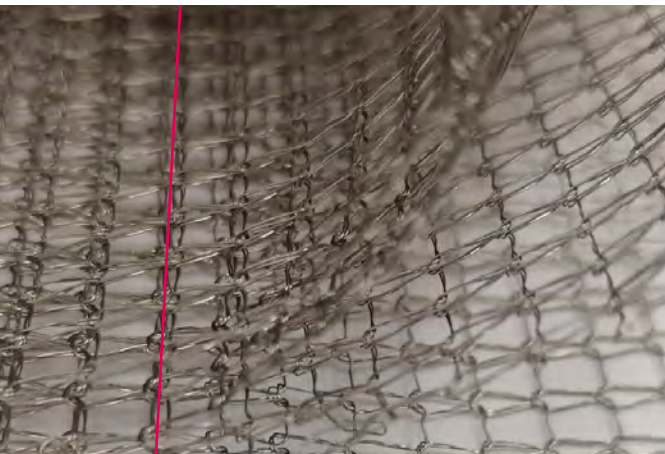
In response to the industry drive for enhanced efficiencies, KnitMesh Technologies has developed an innovative Mesh-Jointing Technology that welds knitted mesh to every contact point of metal plates and adjacent components such as bipolar plates, porous structures, additional knitted mesh, metallic felt and expanded metal.

Electrical contact resistance (ECR) is removed as a result of the unique welding process that forms a single, bonded structure between the knitted mesh and adjacent components.

These photographs show typical welded knitted mesh configurations.

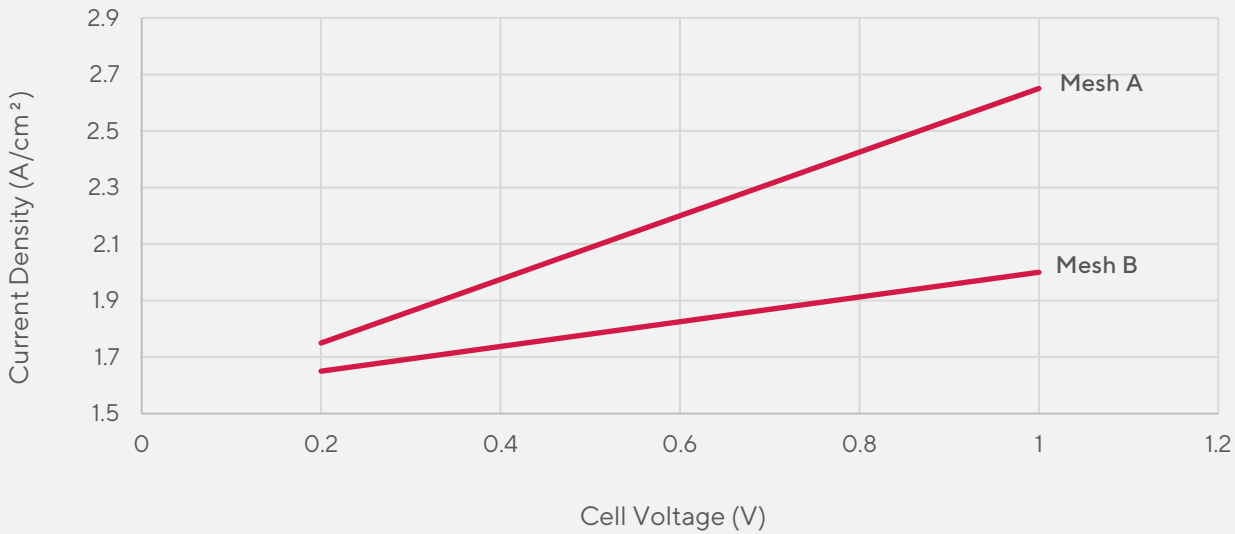


Crimp troughs welded to a base plate (shown as red lines).



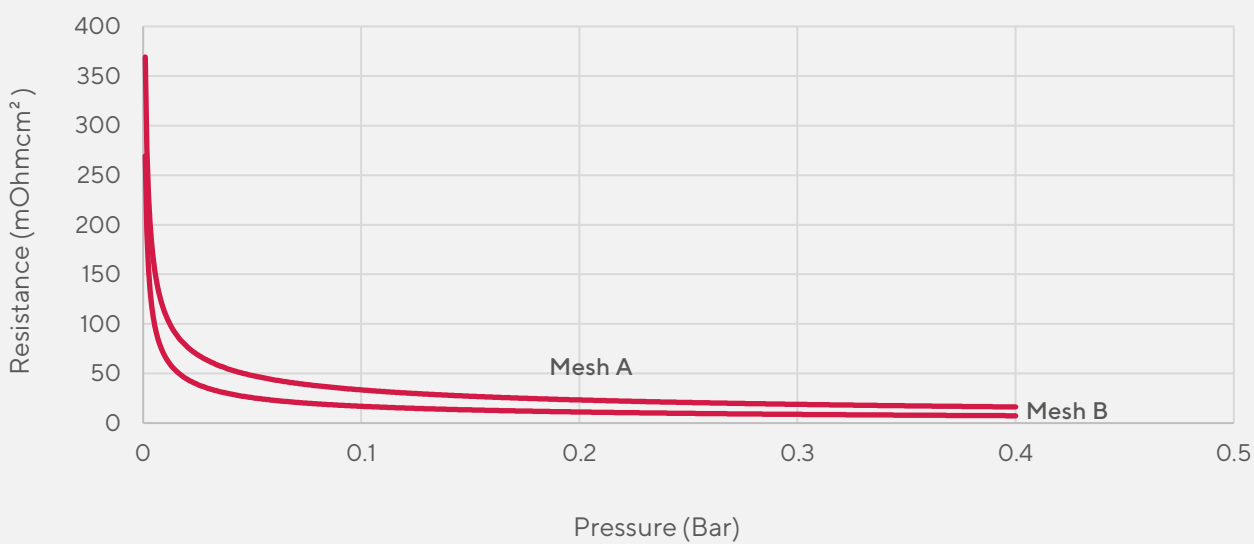
Uncrimped mesh layers welded together (end of weld line shown).

Chart 1: Cell Voltage vs Current Density



Typical current density achieved with various knitted mesh.

Chart 2: Contact Resistance vs Pressure



Pressure on the joint increases and resistance reduces when knitted mesh is compressed within assemblies.

Mechanical Performance

The modulus (compressibility) of the crimped knitted mesh is vital for cell assembly. This ensures that other components, such as the PEM, are subject to the correct pressure which serves to keep them in position without damage.

KnitMesh Technologies has developed a comprehensive range of knitted mesh solutions that enables customers to select the material with the most suitable modulus for their specific application. Chart 3 displays a typical range of compressibilities and a much wider range is available upon request.

The repeatability and consistency of compressed knitted mesh is essential for ensuring the longevity of electrolyzers, as they operate through arduous thermal cycles and demanding process conditions.

Knitted mesh exhibits outstanding levels of resilience meaning compressibility losses through load-cycling can be virtually eliminated. Chart 4 displays the superior cyclic loading performance of knitted wire mesh.



Chart 3: Load vs Compression

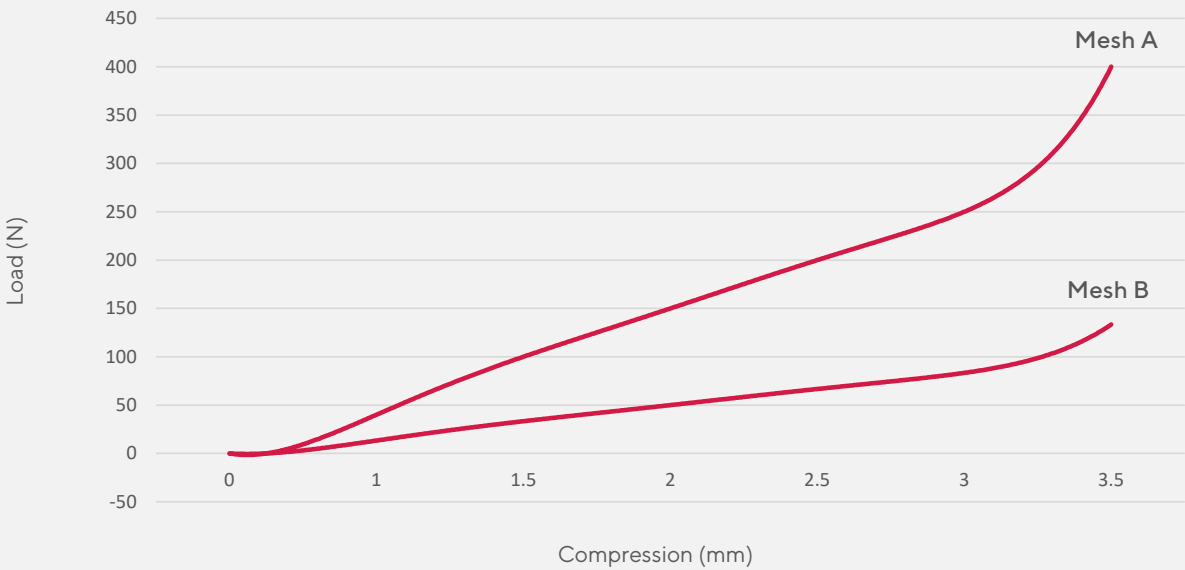
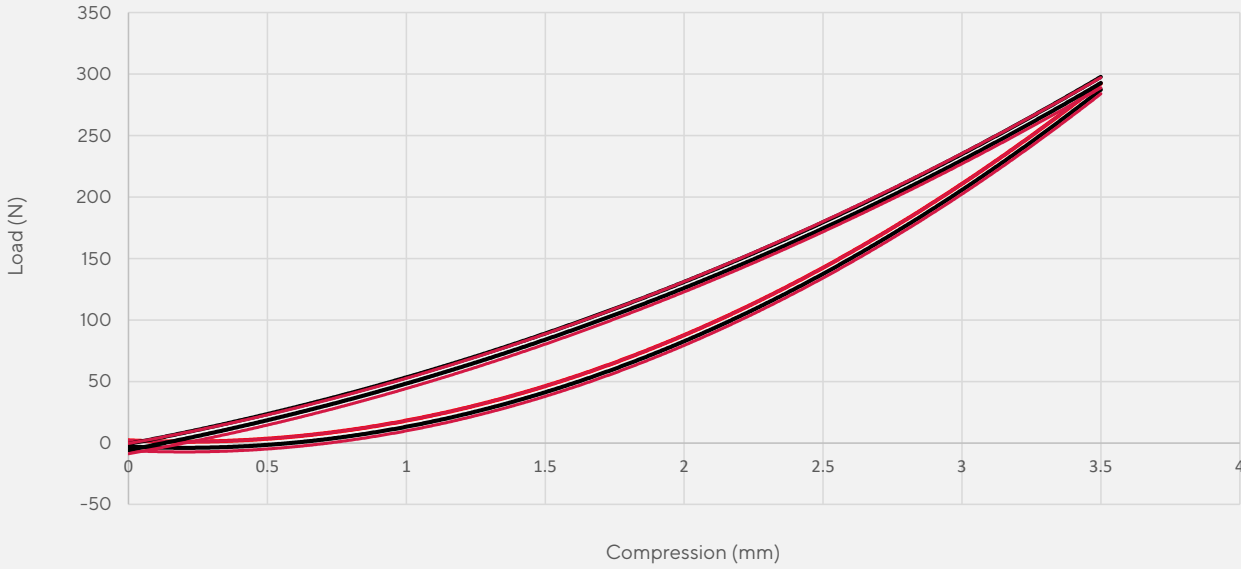


Chart 4: Load vs Compression - Cyclic Loading & Unloading



Knitted Mesh Forms

Flat Mesh

Flat mesh is a high-strength yet flexible material comprising a series of interlocking wire or filament loops.

- **Loop size:** 2mm to 20mm
- **Filaments:** single or multiple filaments (0.05mm to 0.70mm)
- **Electrical properties:** optional welded structures available
- **Various materials:** including wire, yarn and filament
- **Composite structure:** optional combined materials
- **High density:** optional layering and compressibility



Crimped Mesh

Flat mesh can be processed further into a compressible waveform profile. Customers can select compression characteristics to suit application-specific requirements.

Crimped mesh is available in the same variations as flat mesh, to include additional parameters such as:

- **Crimp height:** 0mm to 12mm
- **Crimp direction:** optional reversed crimp to prevent “nesting”
- **Welding:** at the “trough” of the crimp



Compressed Mesh

KnitMesh Technologies can compress flat and crimped mesh into a porous structure of virtually any shape.

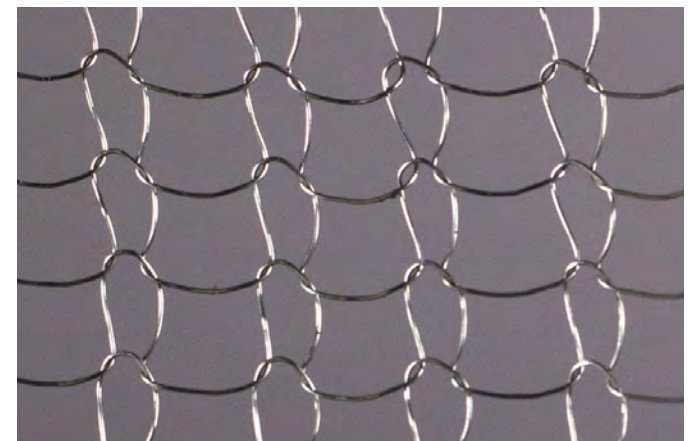
Compressed mesh is available in the same variations as flat and crimped mesh, including these additional parameters:

- **Porosity:** controlled from 50% to 99%
- **Welding:** provides rigidity and reduces electrical resistance
- **Surface area:** 20,000 m²/m³ and 5m²/kg



Materials & Coatings

Common materials for electrolysis applications include nickel, stainless steel grade 316 and titanium. Other materials processed include platinum, gold, carbon fibre and glass wool. KnitMesh Technologies also manufacture coated and plated materials.



For more information on any of our products, please don't hesitate to contact us.

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All specifications are correct at time of print, are for guidance purposes only and subject to change without prior notice.



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