

# The Future Green Power

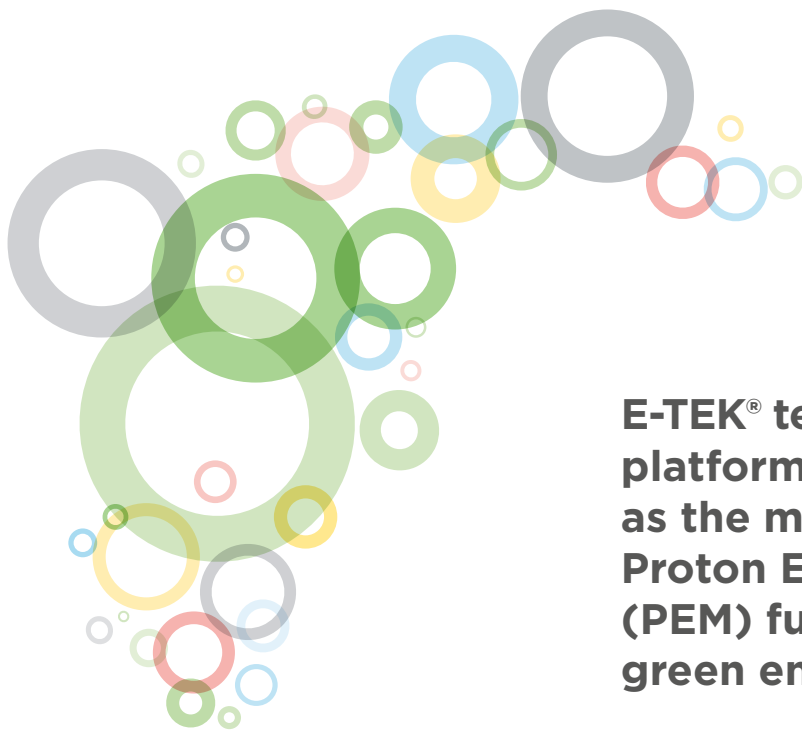
DE NORA E-TEK<sup>®</sup> ELECTRODE TECHNOLOGY FOR ENERGY SOLUTIONS



ELECTROCHEMISTRY AT YOUR SERVICE™

SPECIALTIES & NEWAPPLICATIONS





**E-TEK® technology is a trusted platform worldwide known as the main component in Proton Exchange Membrane (PEM) fuel cells, the future green energy.**

*De Nora pioneered and patented E-TEK® technology designing, developing and supplying Gas Diffusion Electrodes (GDE), layer and catalyst.*

## **From vehicles to shuttle, from energy storage to power generation in remote areas**



PEM Fuel cells, the core of Power to Power, Stationary power, transport and application in space, contain De Nora E-TEK® Gas Diffusion Electrode technology from the early nineties.

De Nora Gas Diffusion Electrode business involves other applications as recovering energy from hydrogen produced as a by-product in chlor-alkali plants, industrial electrolytic processes, gas sensors, metal/air batteries, research and development activities.



## **MORE POWER from RENEWABLE ENERGY**

Globally recognized as one of the major company in electrochemical technologies, De Nora developed the first prototypes of Gas Diffusion Electrodes to be used in electrochemical separations for hydrogen purification as well as supported catalysts.



***De Nora, after the acquisition of E-TEK® Inc., boosted the performances of E-TEK® products, strengthened their brand awareness and spurred new industrial applications in the Chlor-Alkali electrolysis releasing a brand new family of GDE for the production of chlorine from hydrochloric acid as depolarized cathode.***





# Matching the most complex requirements

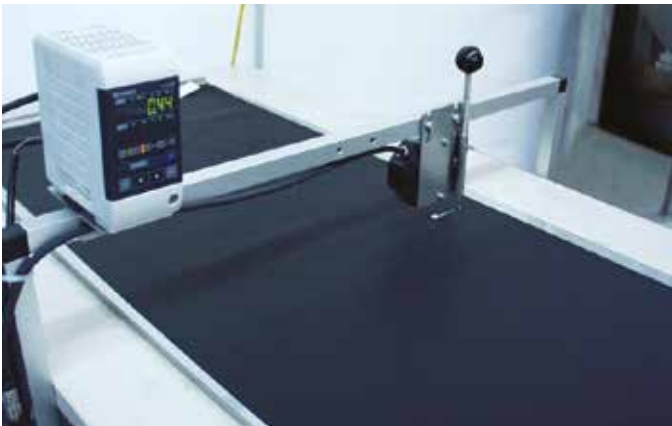


De Nora is today the only manufacturer of Gas Diffusion Electrodes assuring high product standards and the highest production capabilities of carbon coat and catalyst.

**High volume and wide size electrodes** with an highly automated industrial production line.

**Consistent quality and high performances** while controlling costs thanks rigorous process of quality control.

**Most appropriate catalyst layer and customized catalytic coatings** specially developed by our three R&D centers.



## E-TEK<sup>®</sup> gas diffusion

**Late 80's**

Prototech R&D company established

**1992**

Collaboration agreement between De Nora and Prototech development of industrial application in fuel cells and sulfate splitting

**2000**

first industrial line for ELAT production

**Early 90s**

First patent: Platinum carbon supported catalyst. First gas diffusion electrode: ELAT

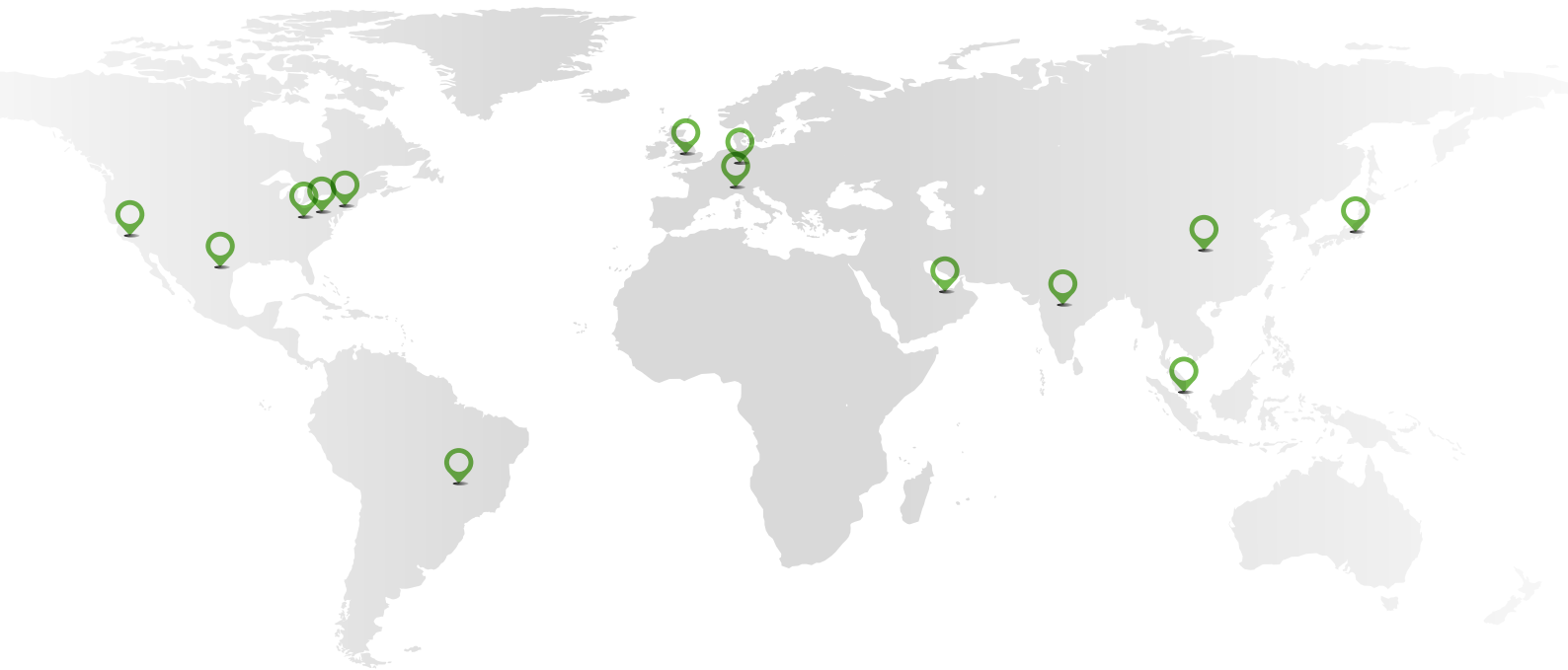
**1996**

E-TEK<sup>®</sup> company established as spin-off from Prototech and subsequently acquired by De Nora

**2002**

Development of ELAT electrode for high temperature PEM Fuel Cells





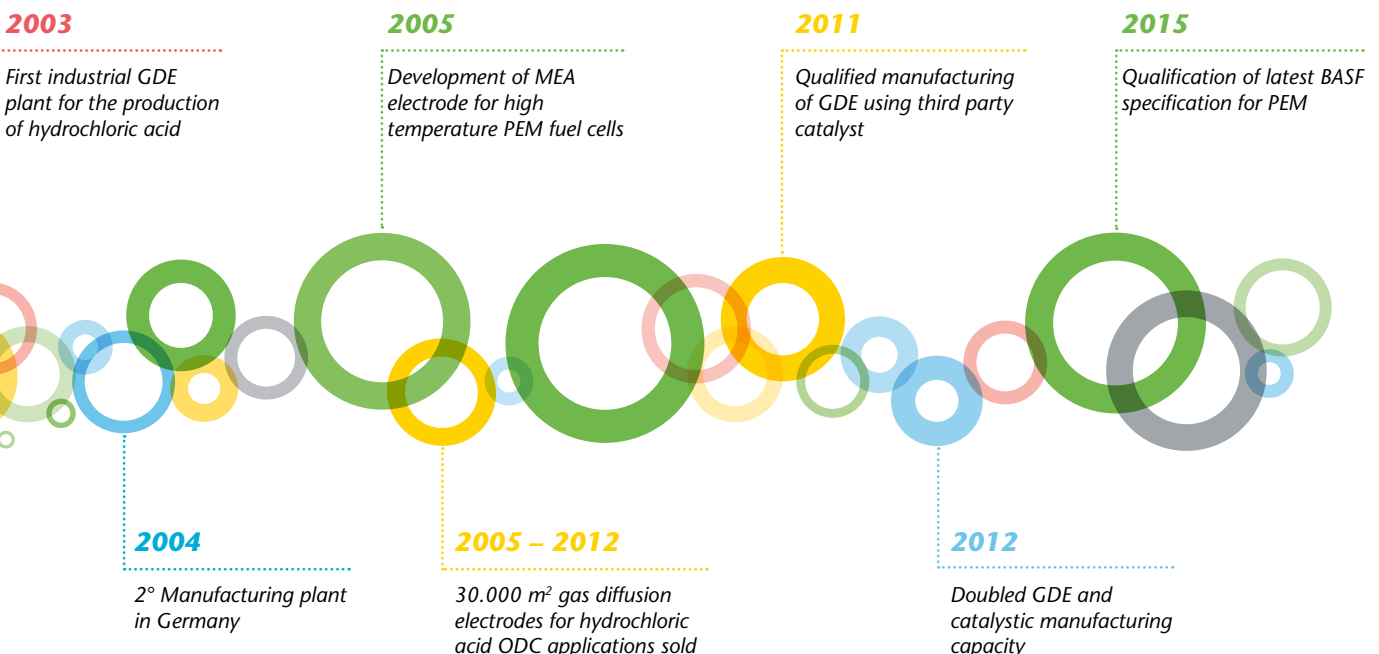
# Worldwide regardless of where you are

From our newest manufacturing plant in China to Brazil, India to the USA, Germany, Japan and beyond, De Nora facilities and skilled professionals are around the world to be close to you.

With over 90 years' experience in designing and manufacturing electrodes and in continuously formulating and patenting noble metals coatings for enhancing performances of electrochemical processes, we provide standard gas diffusion electrodes as well as customized solutions with different gas diffusion layers and ad hoc gas diffusion catalytic developed in our R&D centers.

The MEA stack of PEM are factory assembled.

## electrode milestones



## DE NORA E-TEK® BLACK GAS DIFFUSION ELECTRODE

The **E-TEK® BLACK electrode**, a carbon cloth layer coated with De Nora's patented catalyst layer, is suitable for use in a variety of applications in both alkaline and acid electrolytes. Since the catalyst coating extends throughout the web structure, sometimes this electrode is preferred in case of penetrating electrolytes such as potash or caustic soda.

### Description:

- The standard support is a plain weave carbon cloth of 116 g/m<sup>2</sup>
- The support thickness is approximately 0.35 mm
- The finished catalyzed electrode ranges from 0.45 mm to 0.55 mm depending on the catalyst loading requested
- Catalyst is applied to both sides of this electrode

- The nominal Pt loading using 10% Pt on Vulcan XC-72 is 0.5 mg/cm<sup>2</sup>. The uncatalyzed carbon only loading is 4÷5 mg/cm<sup>2</sup>
- Typical Transition Metal (TM) loading tolerance is ± 10% (x mg/cm<sup>2</sup>)
- The electrode does not have a strongly hydrophobic sub layer

### Options:

Customized catalyst loading are also possible. This type of electrode is available on other carbon cloths (different weave and weight). A micro porous fluorocarbon backing is available.

### Size:

Available in sheet or roll forms (45 cm in width and 1 to 20 m in length).

## DE NORA E-TEK® NOSE SENSOR ELECTRODE

The **E-TEK® NOSE ELECTRODE** is recommended for commercial gas sensor that use button - type cells. These can be used for detecting Cl<sub>2</sub>, SO<sub>2</sub>, H<sub>2</sub>S, NO<sub>x</sub>, CO, H<sub>2</sub>, etc.

### Description:

- The standard support is a micro porous fluorocarbon non conductive film
- The finished catalyzed electrode ranges from 0.15 mm to 0.50 mm depending on the catalyst loading requested

- Catalyst is applied to one side only
- Typical TM loading tolerance is ± 10% (x mg/cm<sup>2</sup>)

### Options:

Customized catalyst loading are also possible. Customer supplied micro porous fluorocarbon supports can be used upon request.

### Size:

Available in sheet or roll forms (45 cm in width and 1 to 20 m in length).

## E-TEK® BLACK-DRY ELECTRODE

This electrode is suitable for use in solid polymer electrolyte fuel cells. In the uncatalyzed form, the E-TEK® BLACK-DRY ELECTRODE can be used as a diffuser with Membrane Electrode Assemblies (MEA). The solid polymer electrolyte electrode is used in various electrolytic applications as well.

### Description:

- Single or double sided electrode (cloth based)
- The standard support is a plain weave carbon cloth of 116 g/m<sup>2</sup>
- The support thickness is approximately 0.35 mm
- The finished catalyzed electrode ranges from 0.45 mm to 0.55 mm depending on the catalyst loading requested
- The nominal Pt loading using 10% Pt on Vulcan XC-72 is 0.5 mg/cm<sup>2</sup>

- Typical TM loading tolerance is ± 10% (x mg/cm<sup>2</sup>)
- Gas side wet proofing is by means of hydrophobic fluoro carbon / carbon layer on one side of cloth / paper only

### Options:

Customized catalyst loading are also possible. This type of electrode is available on other carbon cloths (different weave and weight) / paper. Custom configuration with different PTFE loadings available (range 10 – 60%).

### Size:

Available in sheet or roll forms (45 cm in width and 1 to 20 m in length).

## E-TEK® LIGHT UNSUPPORTED ELECTRODES

For special purposes, electrodes may be fabricated without the use of a support material such as carbon paper, carbon cloth or metallic mesh. Such freestanding electrodes are structures formulated from catalyzed carbon and fluoro – carbon dispersion alone.

### Description:

- Both E-TEK® BLACK and E-TEK® BLACK-DRY electrode configurations can be customized
- Typical customization includes PTFE loadings
- De Nora can also customize the architecture of each electrode style

## E-TEK® SUITE MEA

This assembly of gas diffusion electrodes and ion exchange membrane is suitable as a monolithic component in polymer electrolyte membrane fuel cell (PEMFC) as well as in a variety of electrochemical applications such as in sensing or electro synthesis. The standard single side E-TEK® BLACK-DRY ELECTRODE is most often used as gas diffusion electrode component. The ion exchange membrane can be a polybenzimidazole based membrane (PBI) or a membrane provided by the customer.

### Description:

Active area:

- Square or circular with single side E-TEK® BLACK-DRY ELECTRODE 20% Pt/C 0.5 mg/cm<sup>2</sup> TM loading
- Polybenzimidazole ion exchange membrane
- Circular MEAs will require a die provided by the customer
- Typical TM loading tolerance is  $\pm 10\%$  (x mg/cm<sup>2</sup>)

- Standard PEMFC MEA (H<sub>2</sub>/air) is 0.5 mg/cm<sup>2</sup> TM loading using 20% Pt on Vulcan XC-72 for anode and cathode
- Standard Direct Methanol FC (DMFC) MEA comprised of 4.0 mg/cm<sup>2</sup> TM loading using 80% High Performance (HP) PtRu alloy (1:1 a/o) on optimized carbon for anode and 3 mg/cm<sup>2</sup> TM loading using 60% HP Pt on Vulcan XC-72 for cathode
- Standard MEA for use in CO contaminated hydrogen feeds: 0.5 mg/cm<sup>2</sup> TM loading using 20% HP PtRu alloy (1:1 a/o) on Vulcan XC-72 for anode and 0.5 mg/cm<sup>2</sup> TM loading using 20% HP Pt on Vulcan XC-72 for cathode

### Options:

- Custom catalyst and loading available
- Typical MEA membrane is polybenzimidazole based
- Other customer supplied membrane may be used
- Half MEA configuration is available
- Custom catalyst and loading available



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CHLORINE & CAUSTIC INDUSTRY

ELECTRONICS & SURFACE FINISHING

POOLS & ELECTROCHLORINATION

SPECIALTIES & NEWAPPLICATIONS



**DE NORA**  
our research - your future

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