

6770

# Freezer/Mill®

Grinding &  
Pulverizing

## APPLICATION NOTE

### Nafion®-Powder for the Production of Fuel Cell Electrodes

With kind permission of DLR (German Aerospace Center) Stuttgart; Electrochemical & Electrical Engineering

The Freezer/Mill®, a cryogenic mill is useful where other grinding procedures fail. Flexible materials like synthetics and biological samples are embrittled at Liquid Nitrogen temperatures. The sample is hermetically sealed and cross contamination is impossible. Since the Freezer/Mill is driven magnetically there is no wear and tear on the movable parts.

#### Special Polymer

Nafion® a polymer similar to Teflon (perfluorosulfonate polymer), which has been used for over 30 years as a proton conducting membrane in fuel cells, serves as an electrolyte. Because of its properties it proved very suitable for this application. The DLR has now developed a method to apply the Nafion in powder form. For the production of this Nafion powder, the Freezer/Mill, a cryogenic mill is utilized. As a polymer Nafion is very flexible and soft which obviously makes milling difficult. The Nafion granules (5mm particle size) are reduced to approx. 10µm during grinding. The resulting powder is mixed with a catalyst and sprayed dry onto to the 25 - 175 µm thick membrane.

#### Fuel Cell

The fuel cell generates electrical output through electro-chemical oxidization of hydrogen into a proton and an electron as well as oxygen reduction as counter reaction. In order to reduce the necessary activation energy for this reaction a catalyst has to be used. In the PEM-MC (Polymer-Electrolyte-Membrane-Fuel Cell) platinum is used as a catalyst. The direct methanol fuel cell needs ruthenium as a catalyst in addition. These polymer membranes are utilized in various fuel cells.

#### Result (Conclusion)

Despite the special properties of Nafion, which as a polymer is very soft and flexible, it was possible to obtain a very fine powder after a combined grinding time of 20 minutes with the freezer/mill. No particle size determination was carried out, although because of the thickness of the applied layer the maximum particle size can be specified as less than 25µm.

∴ APPLICATION NOTE SP009:  
Reduction / Homogenization

∴ APPARATUS:  
**Freezer/Mill®**

∴ APPLICATION:  
Polymers



SPEX SamplePrep  
15 Liberty St  
Metuchen, NJ 08840 USA  
Tel: 732-623-0465  
Fax: 732-906-2492

E-mail: [Sampleprep@spexcsp.com](mailto:Sampleprep@spexcsp.com)  
[www.spexsampleprep.com](http://www.spexsampleprep.com)

#### European Headquarters

SPEX CertiPrep Ltd  
2 Dalston Gardens  
Stanmore, HA7 1BQ, UK  
Tel: +44 (0)20 8204 6656  
Fax: +44 (0)20 8204 6654  
E-mail: [sales@spexcertiprep.co.uk](mailto:sales@spexcertiprep.co.uk)  
Web: [www.spexcertiprep.co.uk](http://www.spexcertiprep.co.uk)