

Thermiculite[®] 866 Sealing Material

Solid Oxide Fuel Cells

Flexitallic[®]

www.flexitallicsofc.com

Thermiculite® 866

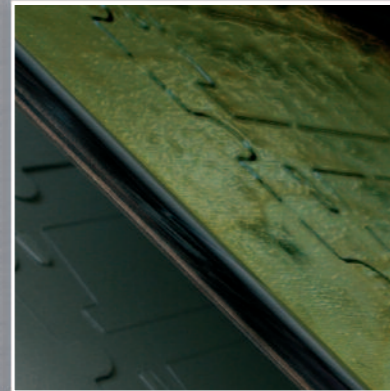
- Thermiculite® 866 is recognised as the material of choice to achieve high sealing efficiency by leading developers of SOFC technology
- Unparalleled performance in multirole applications
- Thermiculite® 866 ensures that a seal is created and then the seal is maintained in service
- No burn off of organic material at elevated temperature
- No reduction in gasket thickness at elevated temperature



Sealing Solid Oxide Fuel Cells with Thermiculite® 866 Compression Seals

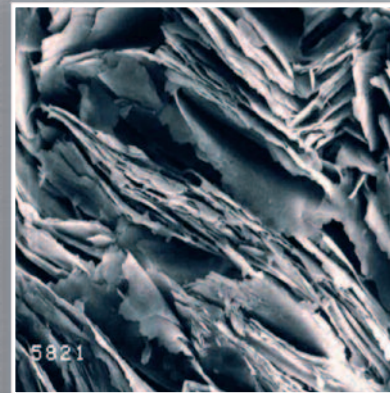
Thermiculite® 866 is a sealing material specifically designed as a compression seal for Solid Oxide Fuel Cells [SOFC]. It is proving to be very successful in a range of SOFC applications around the world.

Thermiculite® 866 is a product utilising the Thermiculite® technology, based upon the use of chemically exfoliated vermiculite, that has been developed by Flexitallic to produce a range of high performance, high temperature, patented, sealing materials for industrial sealing.



Vermiculite, a naturally occurring mineral is closely related to mica, a mineral noted for high temperature capability, high chemical resistance and an electrical insulator. Both mica and vermiculite occur naturally as flakes which consist of a stack of very many crystal plates where each crystal plate is nanometres thick. Those flakes of vermiculite, unlike those of mica, are able to be exfoliated so that the crystal plates separate from each other.

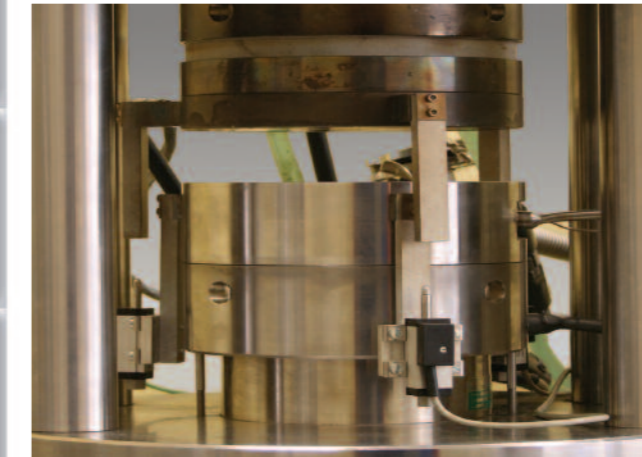
This exfoliation can be done by the application of heat, the result is then the well known form of vermiculite used in many everyday applications such as in gardening compost, as a thermal insulation material, as a packaging material and in fire prevention applications. The very thin crystal plates can also be more efficiently separated from each other by chemical means to produce a form which consists of just these very thin crystal plates. The separated plates, are also highly flexible and have the most useful property of adhering to each other to produce a thin, flexible, film. If a second material is added to the chemically exfoliated material then the second material will be bound by the chemically exfoliated material without the need for the addition of a binder. This binding action of chemically exfoliated vermiculite means that when it is mixed with other, morphology compatible, materials that it is possible to make, by methods developed by Flexitallic, a very flexible sheet material in roll form. This sheet material is readily cut into gaskets of complex shapes.



Crystal plates: Each crystal plate is nanometres thick

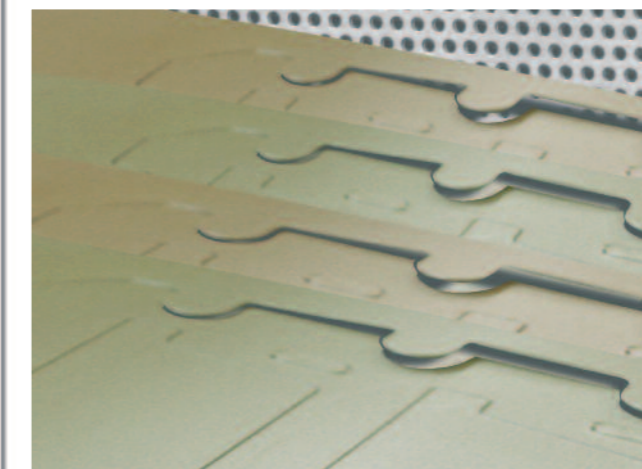
Thermiculite® 866 - The proven sealing material for Solid Oxide Fuel Cell applications

Stable to high temperatures up to 1000°C	No thermal degradation of the seal at SOFC operating temperatures	Extended lifetime performance
No organic filler material	Excellent seal integrity maintained	Material does not become porous over time with no reduction in gasket thickness
Soft and compressible	Easily cut into complex shapes and profiles	Complex sealing arrangements are easily accommodated
Currently operating in service units	Case studies proving the benefits of Thermiculite 866	Many reports of very low leakage rates even through many thermal cycles



Advanced test equipment aided Flexitallic's development of Thermiculite® 866

As there is no burn off of organic material at elevated temperature there is also no reduction in the gasket thickness at temperature and no resulting relaxation of the bolts. The seal is therefore stable during cycling between ambient and operational temperatures. Thermiculite® 866 has resulted in excellent service performance. Figures 1 to 3 show stack results obtained by a customer and reproduced with their full permission.



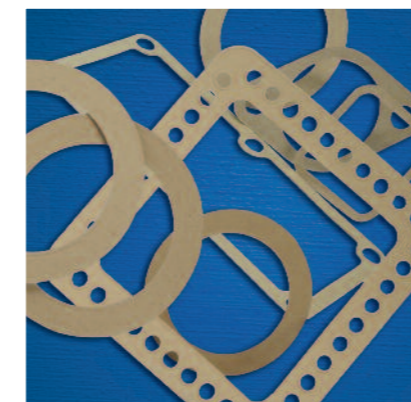
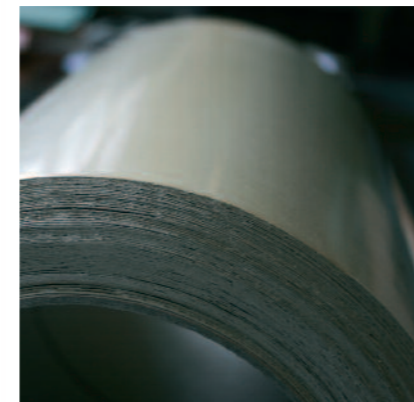
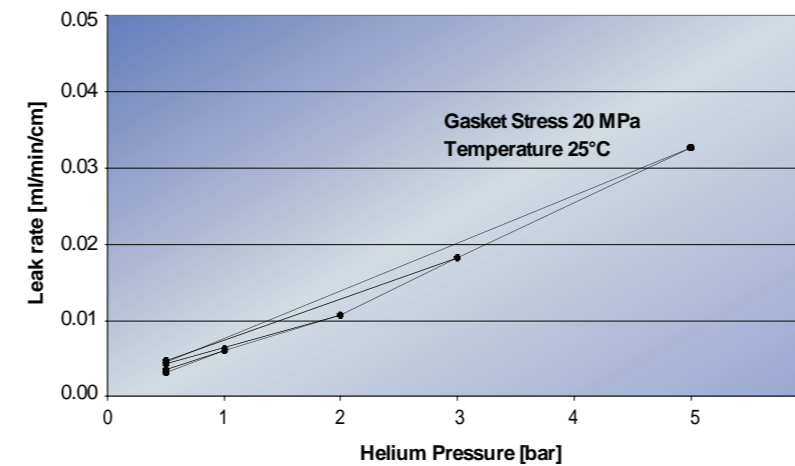
Thermiculite® 866 on a roll - a compressible and flexible material. Gaskets of intricate and complex shape are easily cut.

Recommended Service Conditions for SOFC Sealing Applications

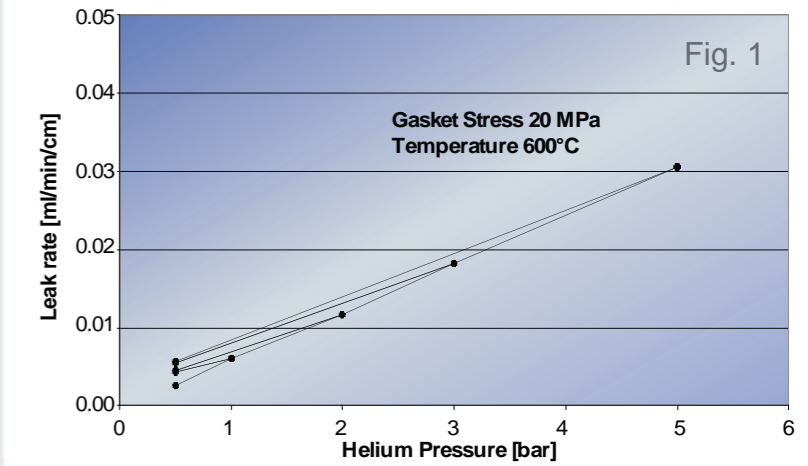
Thermiculite® 866 is designed for, and proven in, Solid Oxide Fuel Cell applications. The components of Thermiculite® 866 ensure that a seal is created and then maintained in service. Consisting of highly aligned platelets of chemically exfoliated vermiculite bound with other unique key ingredients Thermiculite® 866 is very soft, resulting in a compressible and flexible material that is completely free of organic content.

Due to its unique chemical and physical properties, Thermiculite® 866 is highly temperature resistant (1000°C) and, as there is no organic content, there is no burn off of volatile components at SOFC operational temperatures. This ensures that during the lifetime of the fuel cell there is no increase in porosity and no additional leakage at elevated temperature.

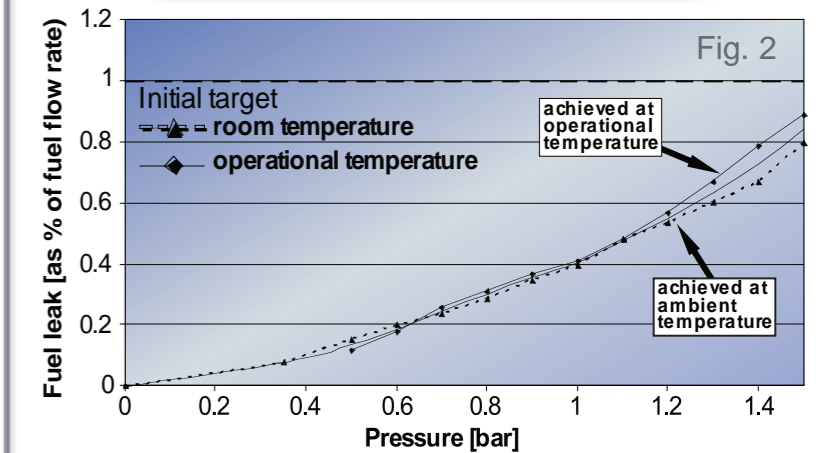
Sealing Curve for Thermiculite® 866 of 0.92mm "as made" thickness at 25°C



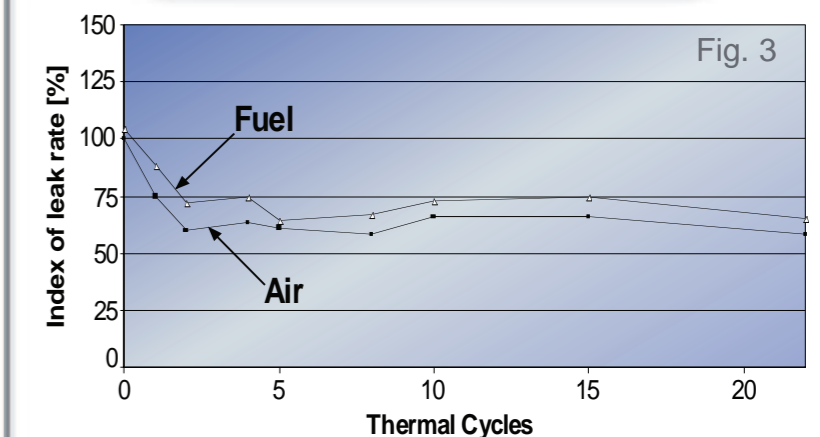
Sealing Curve for Thermiculite® 866 of 0.92mm "as made" thickness at 600°C.



"SOFC Stack Sealing performance achieved with Thermiculite® 866 Compared with initial Project Target".



SOFC Stack Sealing with Thermiculite® 866 Remains stable during Thermal Cycling to Operational Temperature".





The Flexitallic Group

The Flexitallic Group is the international market leader in the manufacture and supply of high quality specialty static sealing products. With the headquarters of the Eastern and Western Hemispheres based in West Yorkshire, UK and Houston, USA respectively, Flexitallic has excellent access to the worlds leading energy businesses and centres of research.

With an enviable record for new product development, Flexitallic is recognised as the leading innovator of new sealing products and materials. Its engineering teams work closely with industrial bodies, leading global energy and engineering companies to ensure that its sealing technology is always in front of industry standards.

In 1998 Flexitallic set a new standard for sealing technology with the introduction of Thermiculite Critical Service gasket materials. Thermiculite is available as a tanged sheet, as filler material for spiral wound gaskets and a facing on kammprofile gaskets. Thermiculite has solved numerous end user problem applications, particularly those with high temperature processes where traditional sealing materials failed. Thermiculite Critical Service materials are rated for temperatures up to 1000°C and have passed the API 607 fire test.

Through continued dedication to research and development Flexitallic added Thermiculite Performance Grade Materials for use in more moderate temperature applications. These Thermiculite materials maintain the same broad chemical resistance and freedom from oxidation that has made the Critical Service Grade such a success. These innovative and versatile materials are available in a calendared sheet and as filler in spiral wound gaskets. They are suitable for replacing aramid fiber, glass fiber, carbon fiber, PTFE and graphite in a wide array of applications. Performance Grade Thermiculite has passed the API 607 fire test.

Flexitallic's global customer service network of owned manufacturing facilities, manufacturing licensees and distribution network ensure local demand is met quickly, with a combination of the highest product quality and customer service.

Flexitallic[®]

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