



2nd International Symposium on Master Engineering

Booklets



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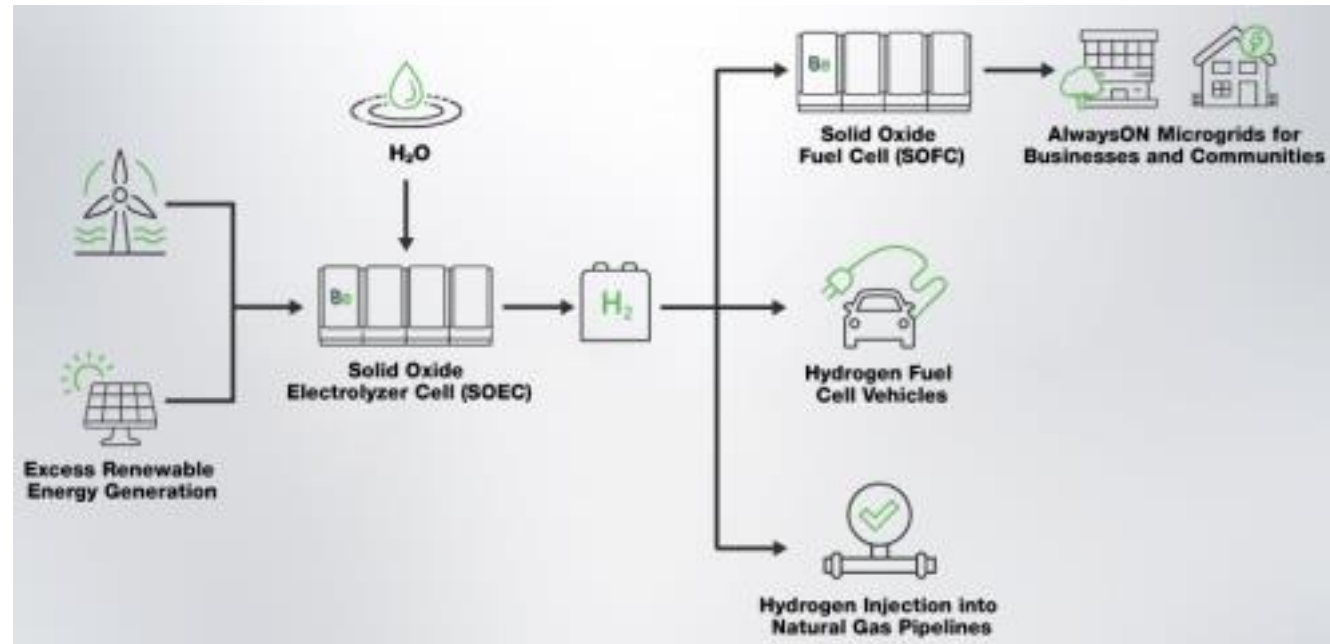
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Mexico	Colombia	Guatemala
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Una futura economía basada en el hidrógeno?



Celdas de Combustible (Fuel Cells)

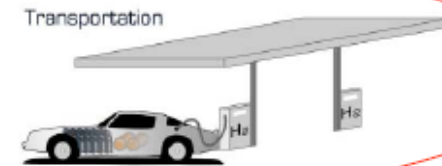
Fuel Cells in operation

B | Z
Bündnis

Portable systems
appr. 3500 systems



Mobile systems
appr. 350 cars

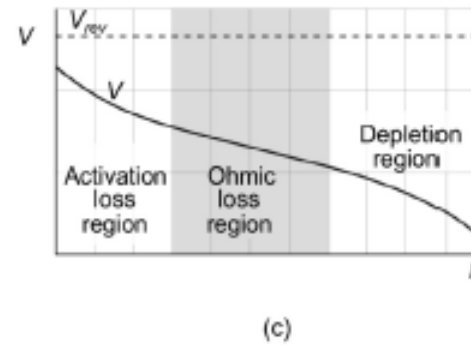
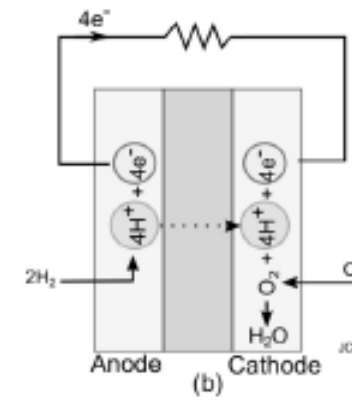
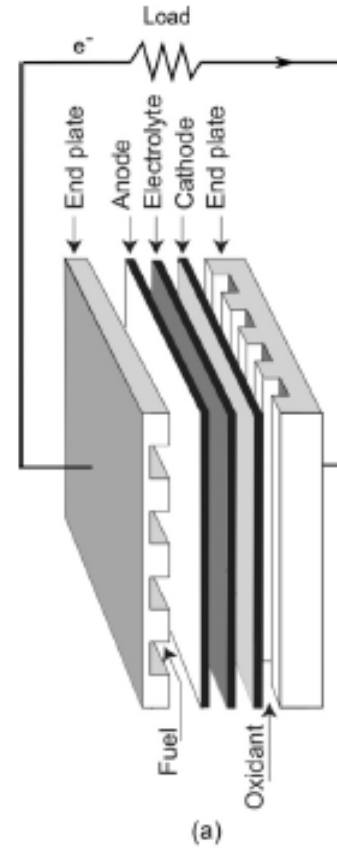


Stationary systems
appr. 2500 systems with overall power of
appr. 130 MW



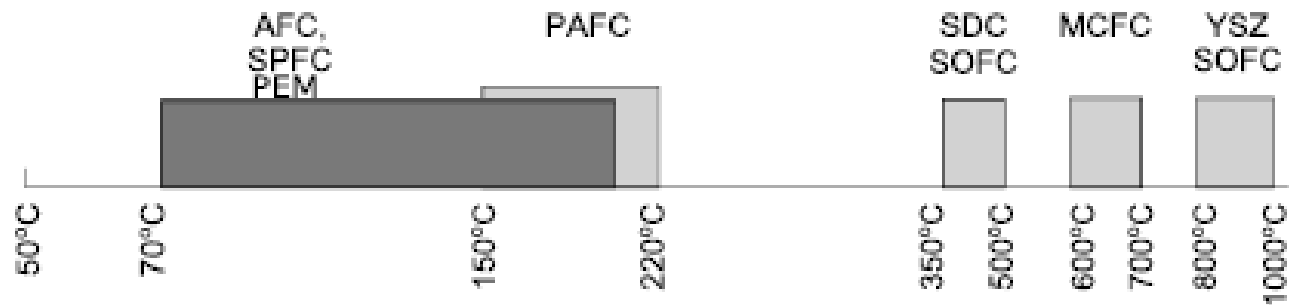
Las celdas de combustible ya están probadas, demostradas y se utilizan.

Qué es una celda de combustible (Fuel Cell) ?

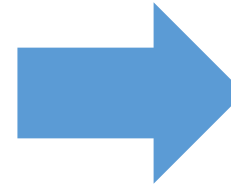
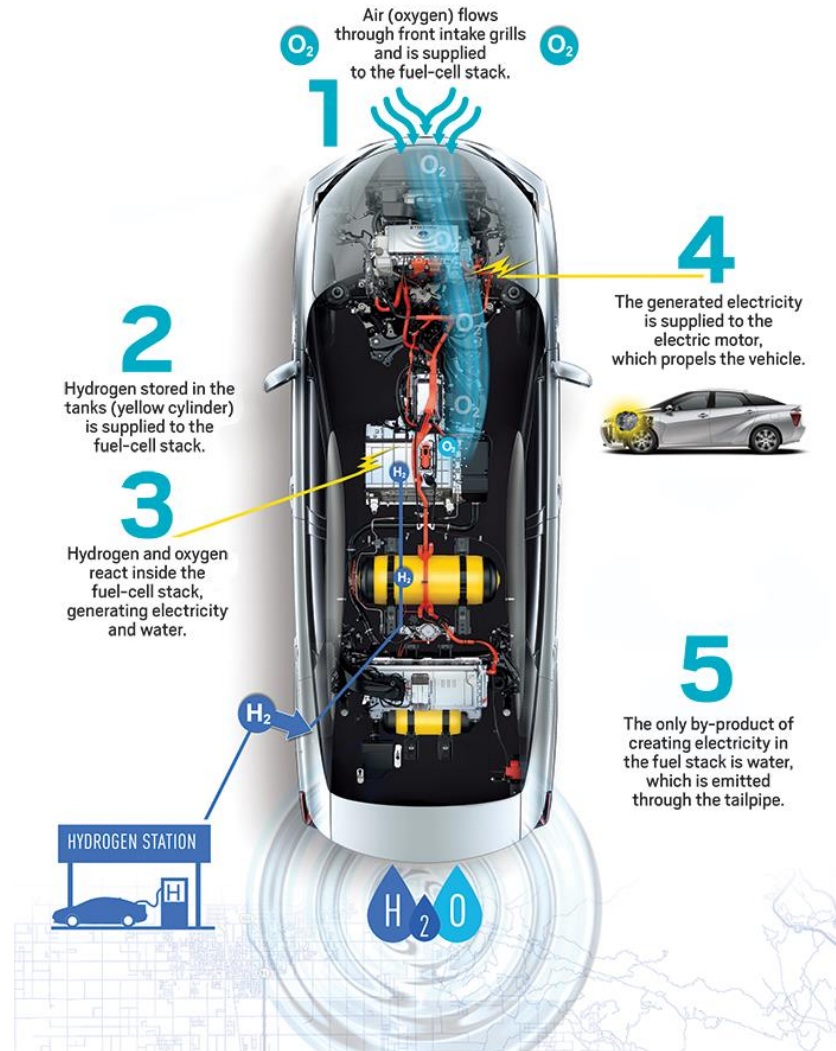


Clasificación de las celdas de combustible

AFC	→	Alkaline fuel cell
DMFC	→	Direct methanol fuel cell
MCFC	→	Molten Carbonate fuel cell
PAFC	→	Phosphoric acid fuel cell
PEM	→	Proton exchange membrane fuel cell
SAFC	→	Solid acid fuel cell
SOFC	→	Solid oxide fuel cell
SPFC	→	Solid polymer fuel cell

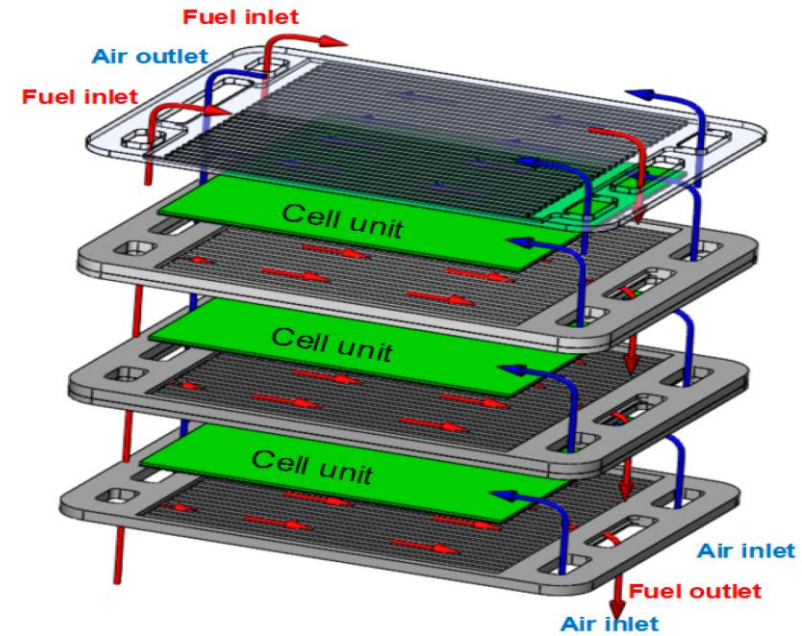


Aplicaciones actuales

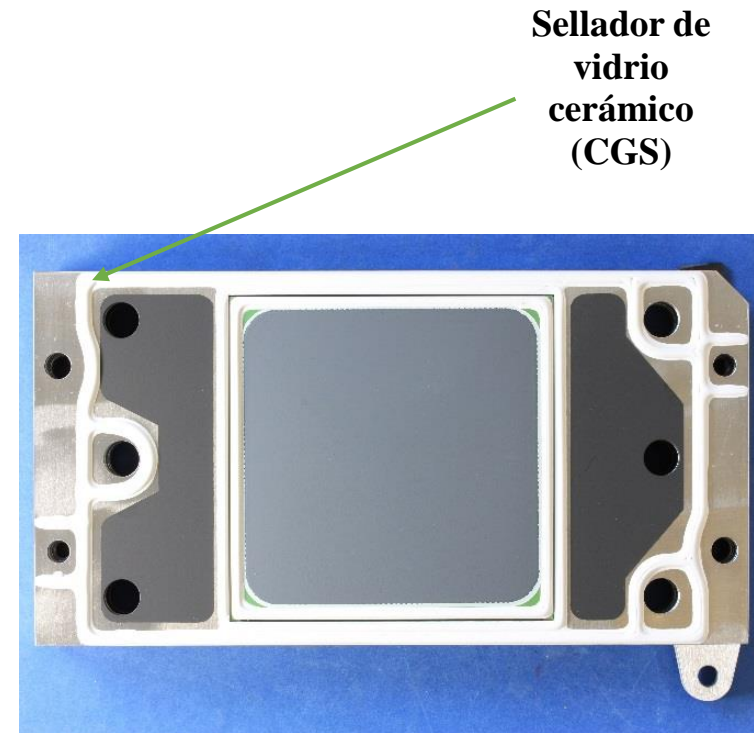
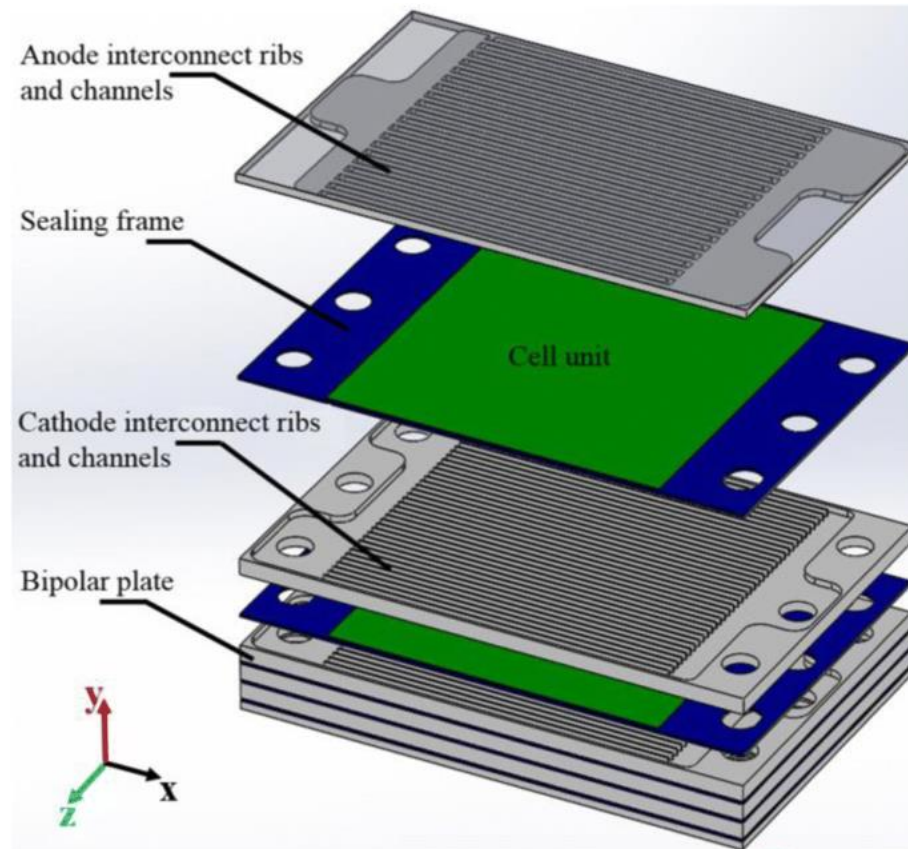


Estación de repostaje de hidrógeno (hidrogenera) (Düsseldorf, Alemania, 2021)

Celdas de combustible de óxido sólido (SOFC)



Potencia: 2 kW
(Forschungszentrum Jülich, 2021)

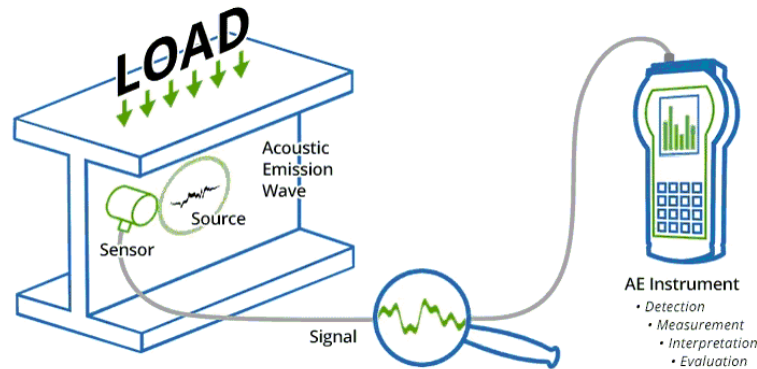


View of anode interconnect
(Forschungszentrum Jülich, 2021)

Técnica de Emisión Acústica

Qué es el Método de Emisión Acústica?

Es un método de prueba no destructivo que se utiliza comúnmente en la detección y localización de fallas y grietas en estructuras cargadas mecánicamente así como en componentes.

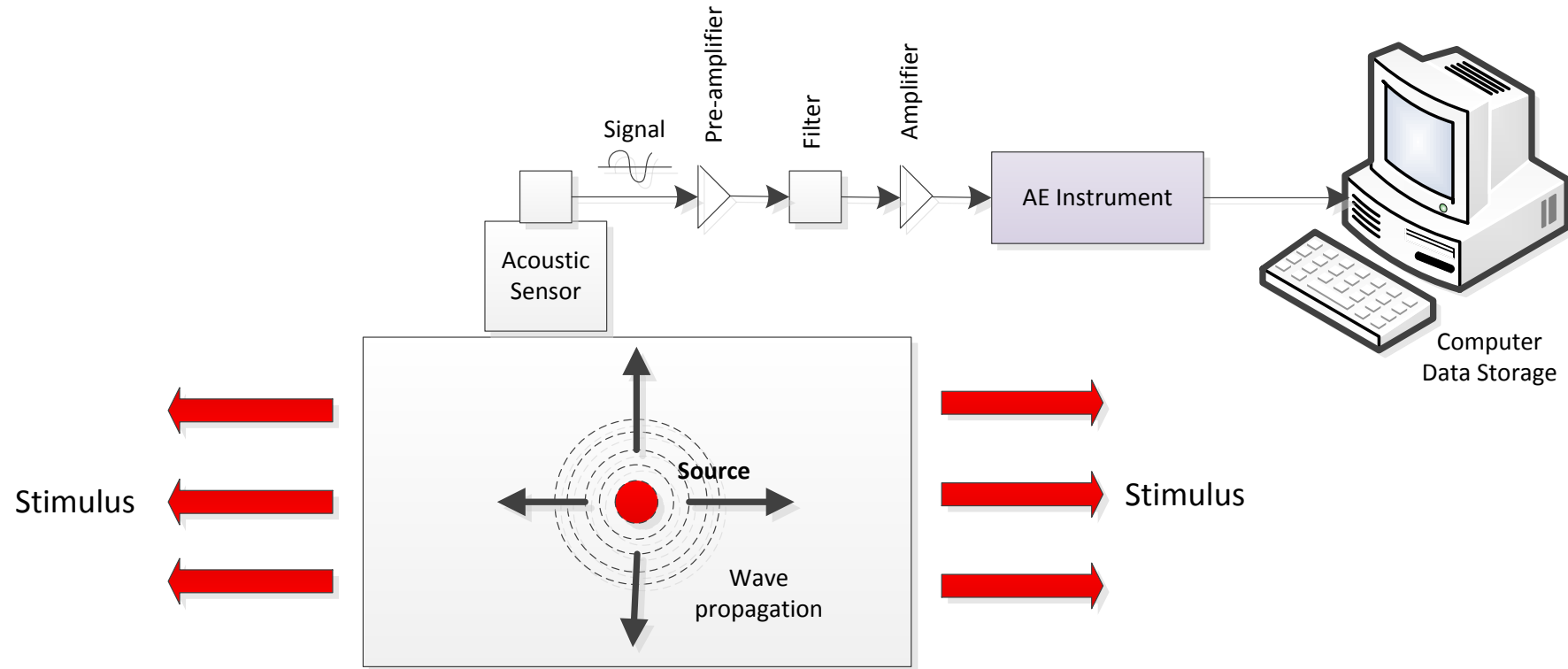


Al método AE se le considera como un método pasivo, ya que la fuente de información se encuentra dentro del componente o material bajo prueba.
(i.e. No requiere de ninguna aplicación externa de energía)

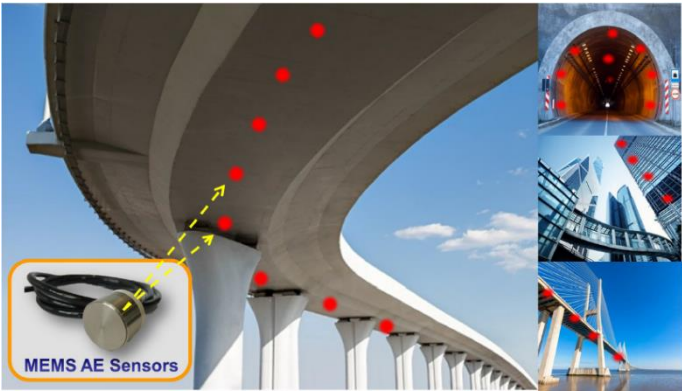
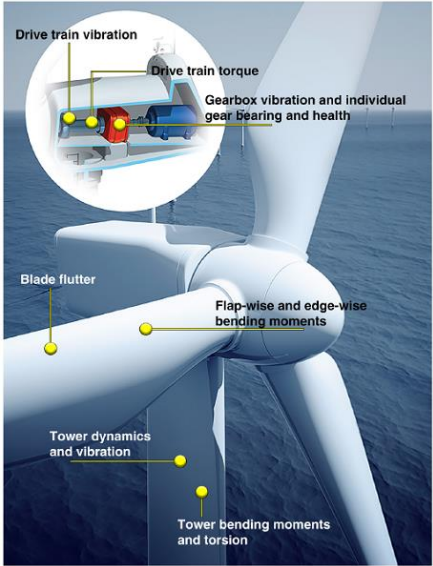
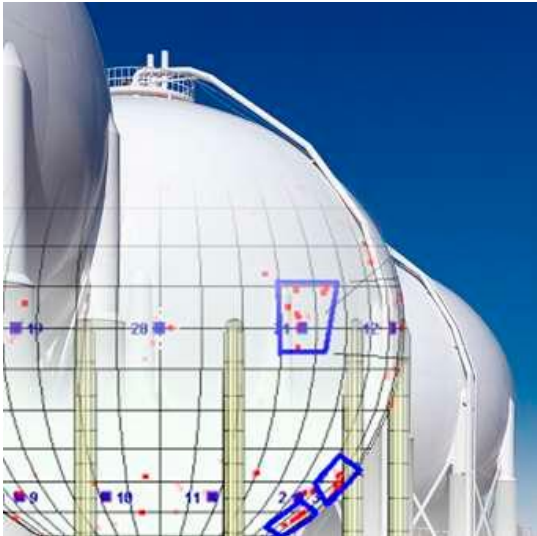
La tecnología involucra el uso de sensores ultrasónicos (20 kHz- 1 MHz) que escuchan el sonido de fractura de los materiales y estructuras.

Las frecuencias de las emisiones acústicas se encuentran típicamente en un rango de 150 a 300 kHz (por encima de la frecuencia del sonido audible).

Principio de las pruebas con Emisión Acústica



Aplicaciones de la Monitorización de Emisión Acústica



Proyecto Experimental

La investigación experimental está orientada a la monitorización acústica de lo que ocurre durante un corte de suministro de H_2 o fuel a la celda de combustible de óxido sólido (SOFC).

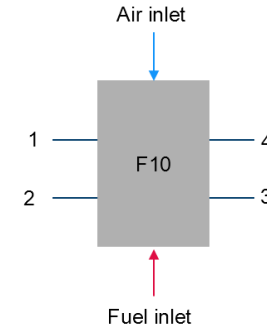
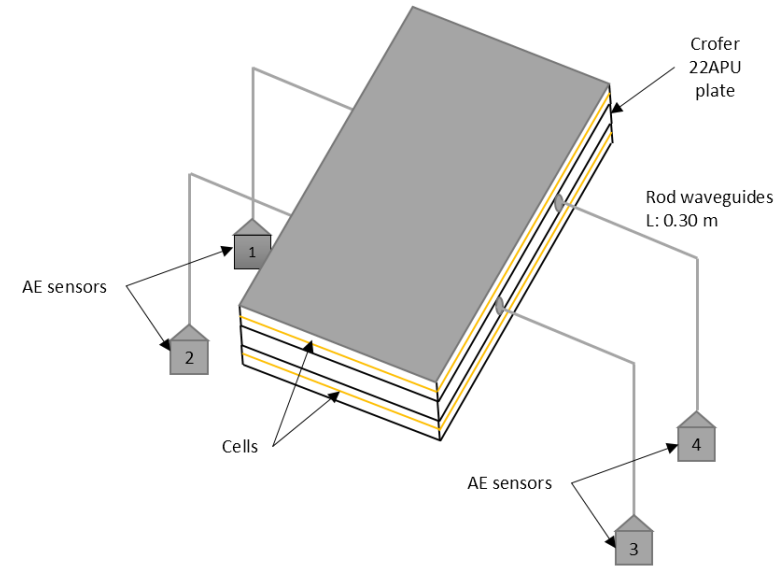
Test set-up and methodology:



Fig. 1. Assembly of AE sensors 1 and 2 in the middle of the Stack.



Fig. 2. Assembly of AE sensors 3 and 4 in the middle of the Stack.



7 REDOX cycles performed so far at 625 °C

0,5 slm air on fuel side

Characterization temperature: 700 °C

Equipo de emisión acústica usado en los experimentos



AE equipment

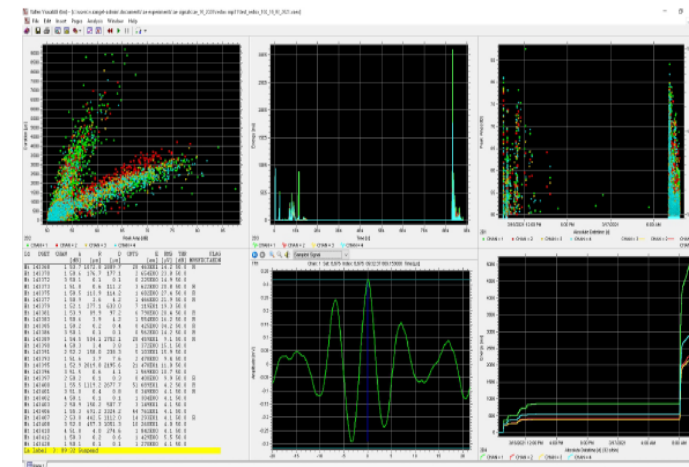
SMC-BNC cable

AE sensor



Preamplifier

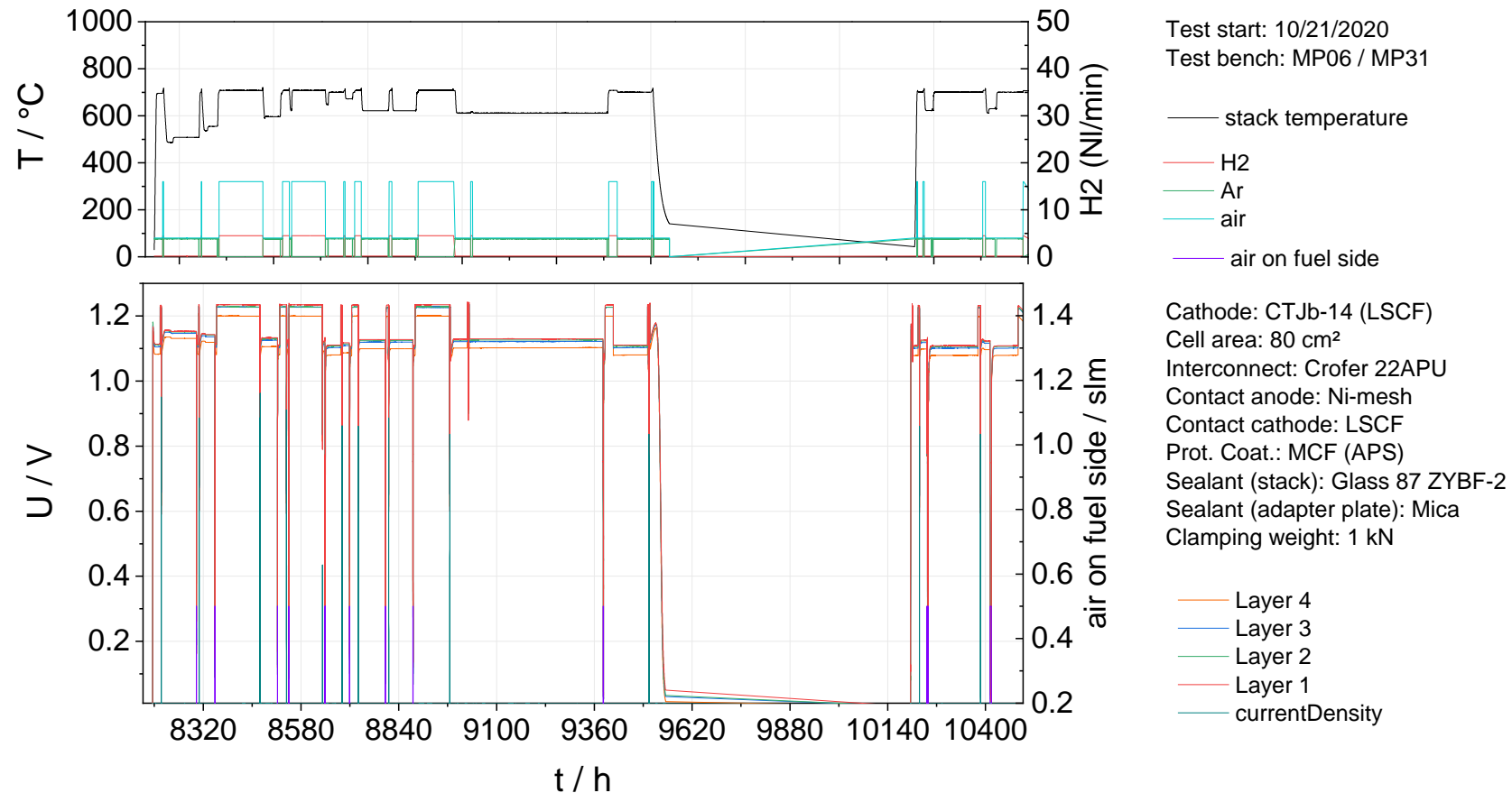
BNC-BNC coaxial cable



Resumen de las pruebas Redox (MP31)

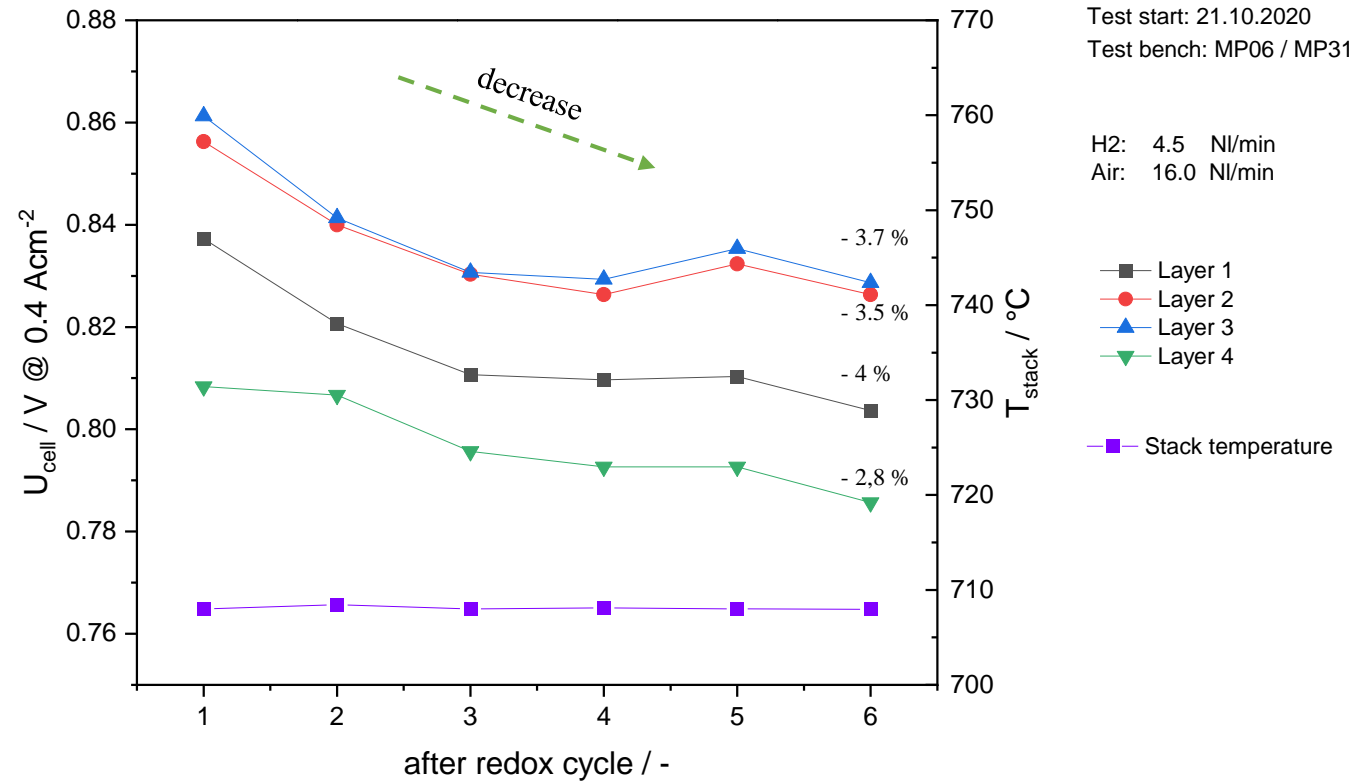
SOC-Sub-Stack **F1004-113**, test-No. SK 698

FuE - Accoustic emission test during redox cycle @ different T's



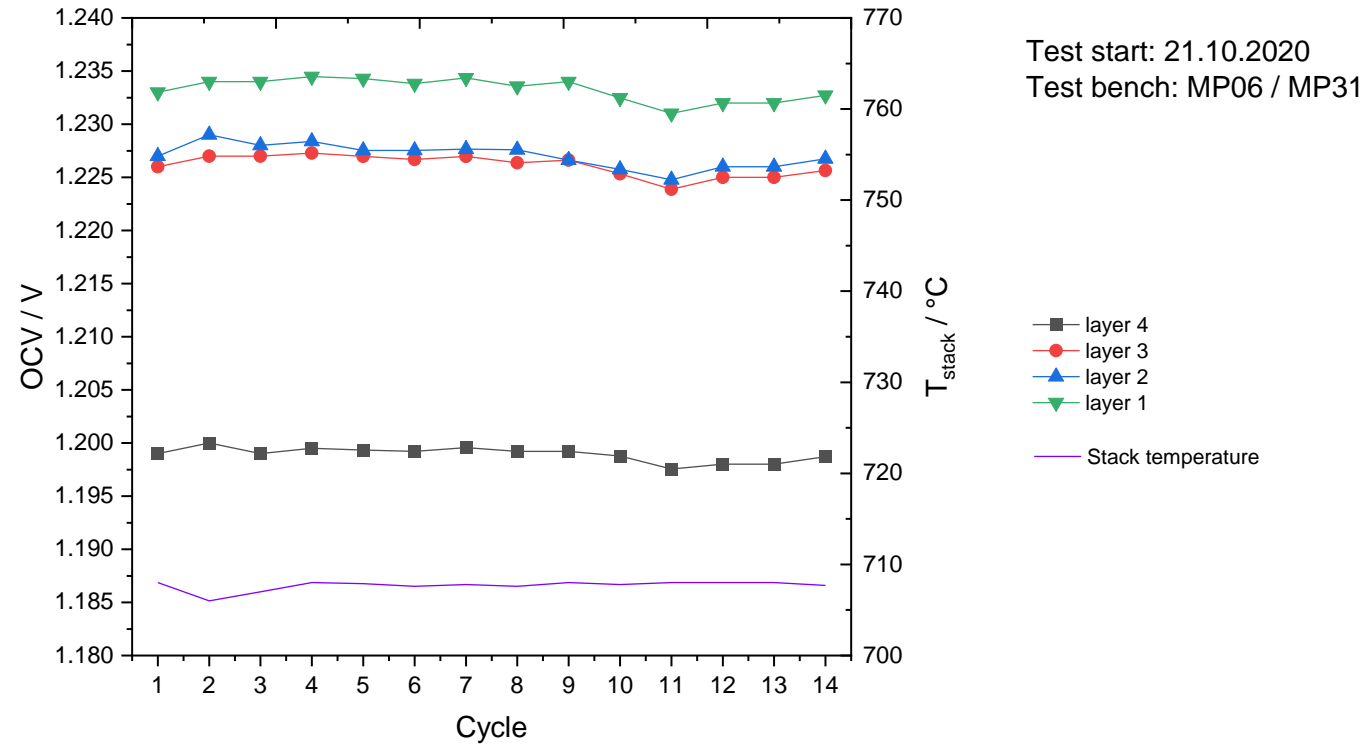
Desempeno de la celda de combustible de óxido sólido

SOC-Sub-Stack F1004-113, test-No. SK 698
 FuE Acoustic emission test during redox cycle @ 625 °C
 Comparison performance cells after redox cycles



Evolution of stack OCV

SOC-Sub-Stack F1004-113, test-No. SK 698
 FuE Acoustic emission test during redox cycle @ different T's
 Comparison OCV @ 700 °C



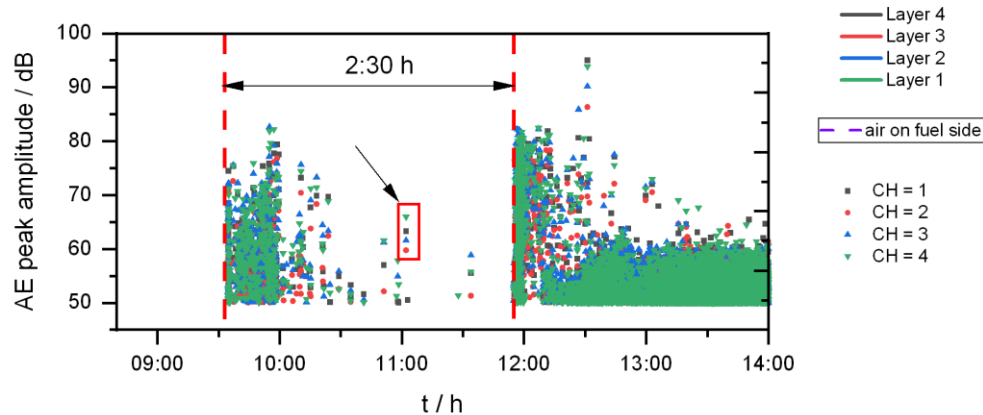
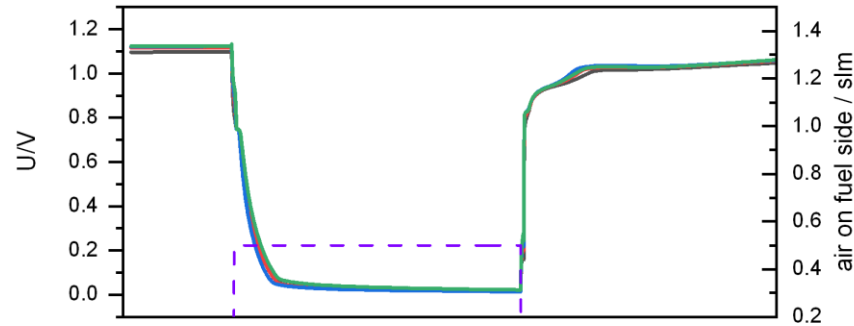
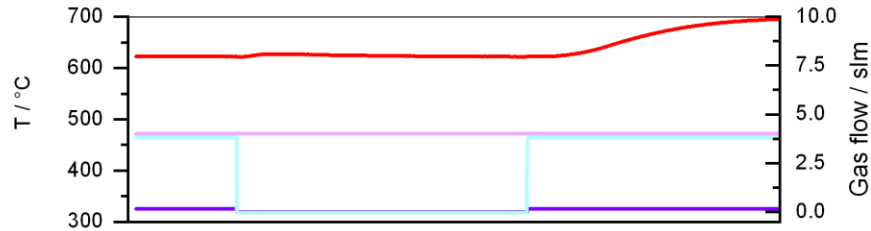
SOC-Sub-Stack F1004-113, test-No. SK 698
 FuE - AE activity during redox cycle @ 625 °C



Test start: 10/21/2020
 Test bench: MP06 / MP31

Cathode: CT Jb-14 (LSCF)
 Cell area: 80 cm²
 Interconnect: Crofer 22APU
 Contact anode: Ni-mesh
 Contact cathode: LSCF
 Prot. Coat.: MCF (APS)
 Sealant (stack): Glass 87 ZYBF-2
 Sealant (adapter plate): Mica
 Clamping weight: 1 kN

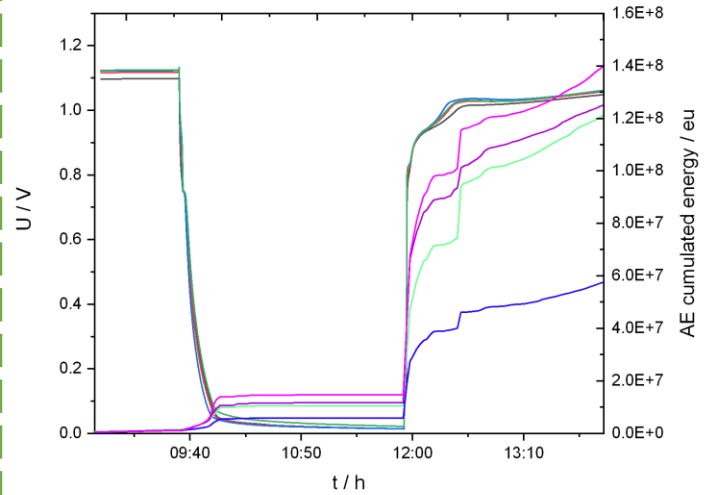
— H2
 — Ar
 — Air
 — TStack



SOC-Sub-Stack F1004-113, test-No. SK 698
 FuE - Absolute AE energy during redox cycle @ 625 °C

Test start: 10/21/2020
 Test bench: MP06 / MP31

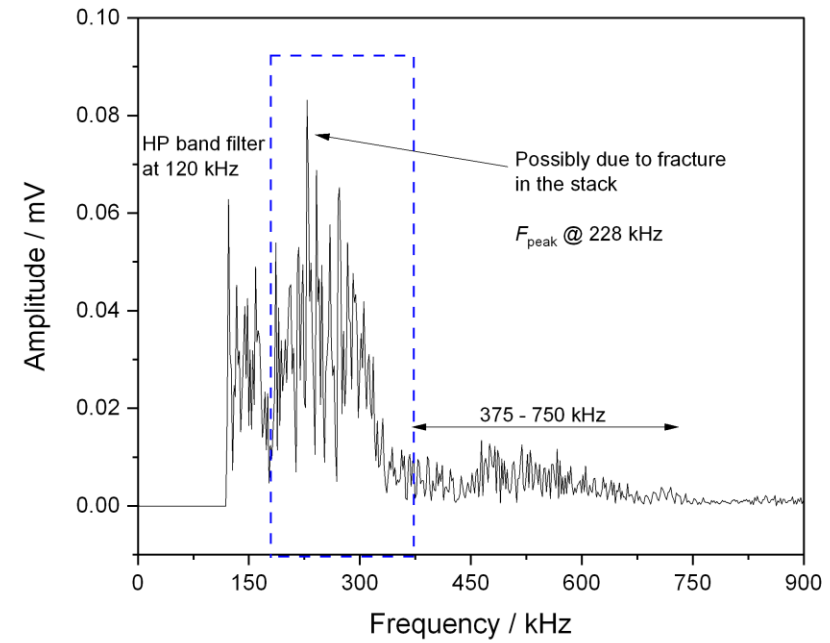
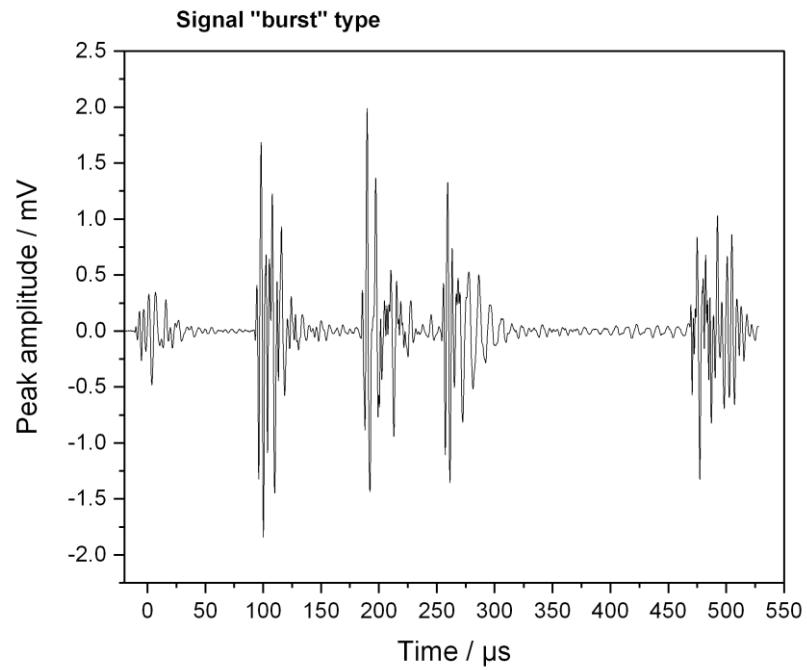
Cathode: CT Jb-14 (LSCF)
 Cell area: 80 cm²
 Interconnect: Crofer 22APU
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 Contact cathode: LSCF
 Prot. Coat.: MCF (APS)
 Sealant (stack): Glass 87 ZYBF-2
 Sealant (adapter plate): Mica
 Clamping weight: 1 kN



Air inlet: Ch 1 and 4

Gas inlet: Ch 2 and 3

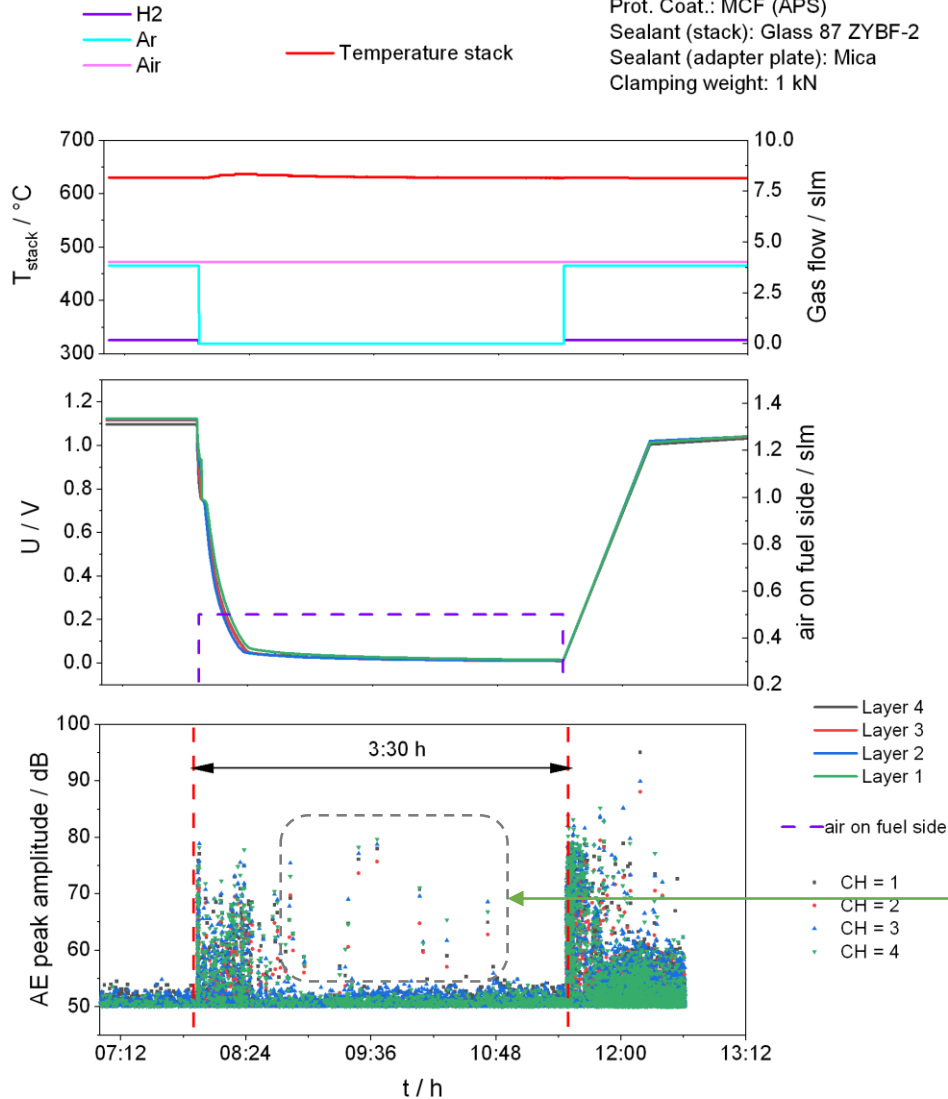
Analysis of AE signal recorded at channel 4



SOC-Sub-Stack F1004-113, test-No. SK 698
FuE - AE activity during redox cycle @ 625 °C

Test start: 10/21/2020
Test bench: MP06 / MP31

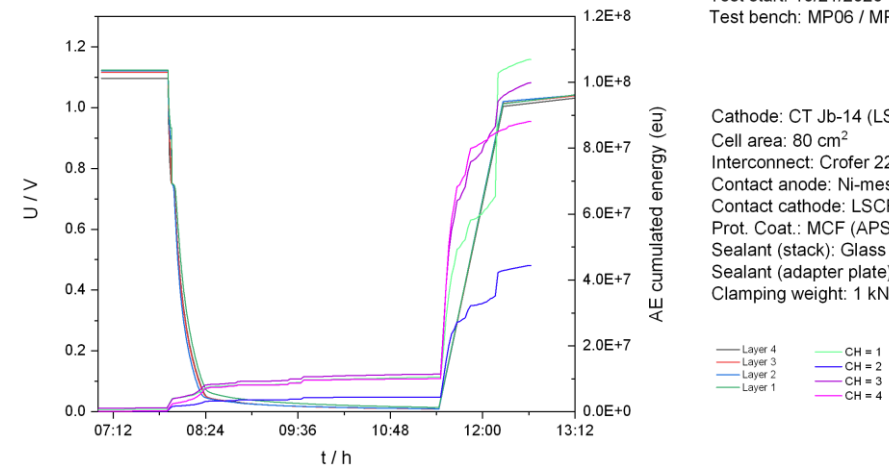
Cathode: CT Jb-14 (LSCF)
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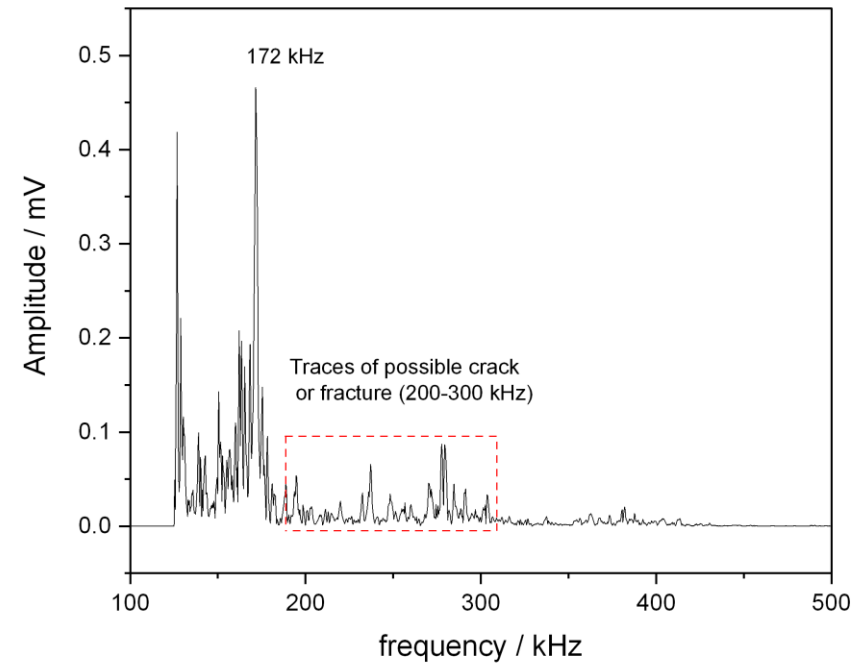
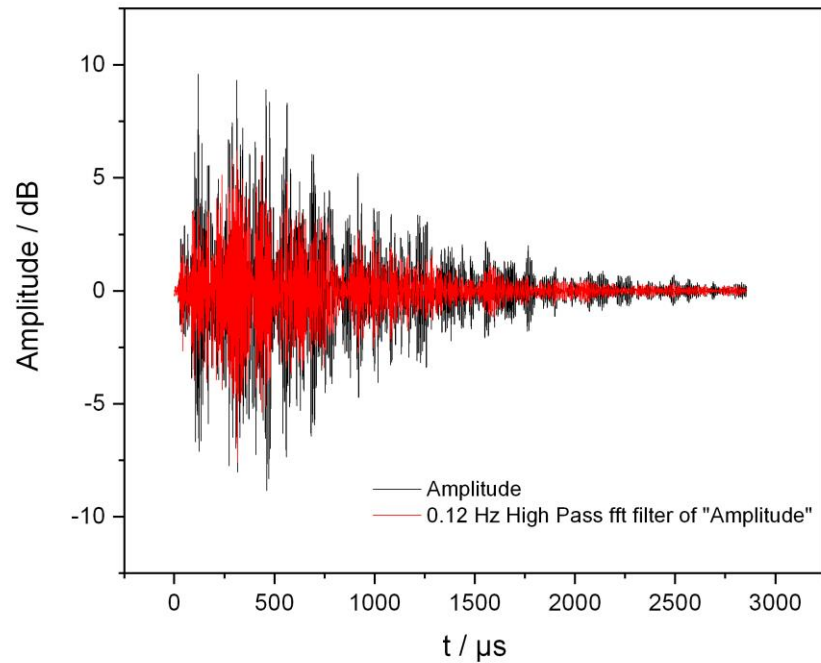
SOC-Sub-Stack F1004-113, test-No. SK 698
FuE - Absolute AE energy during redox cycle @ 625 °C

Test start: 10/21/2020
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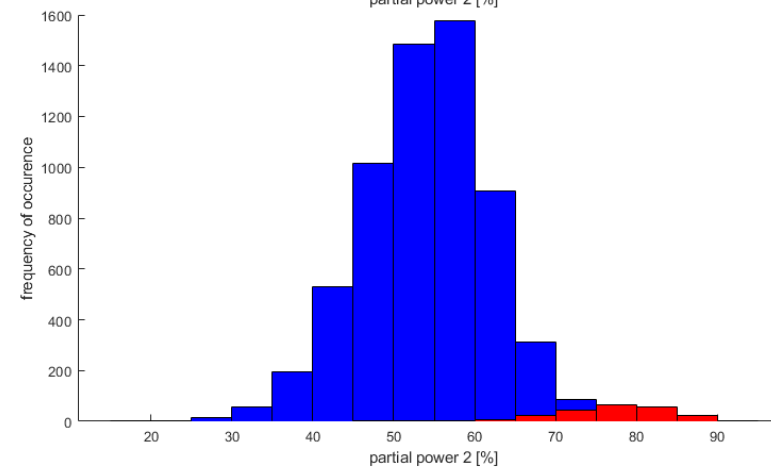
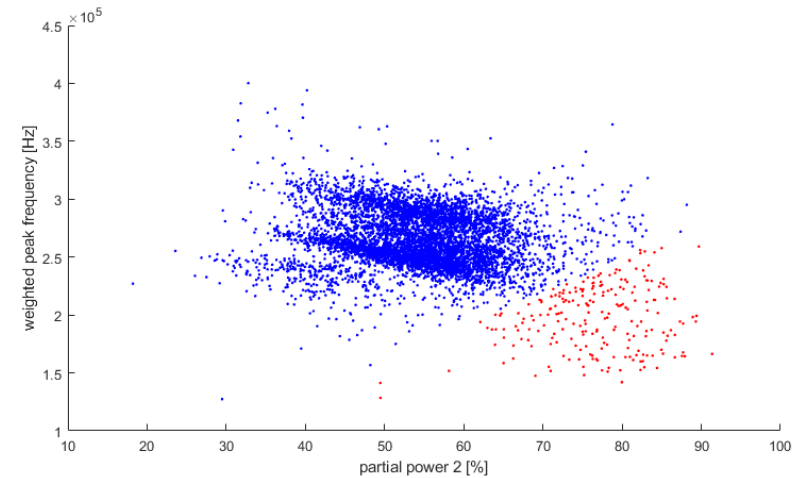
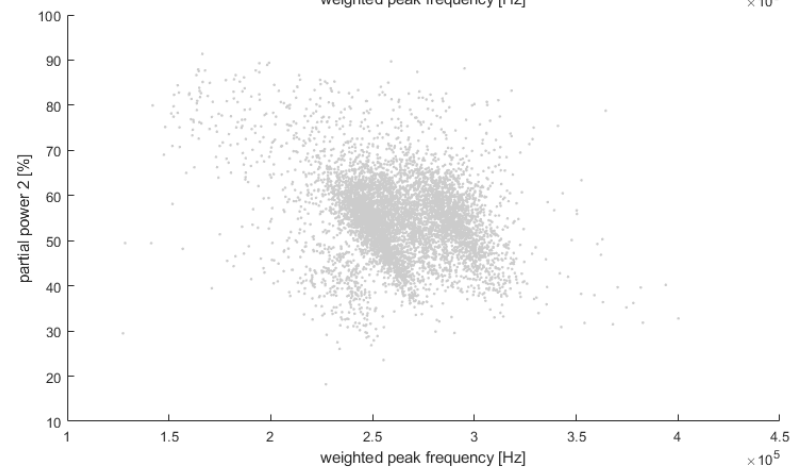
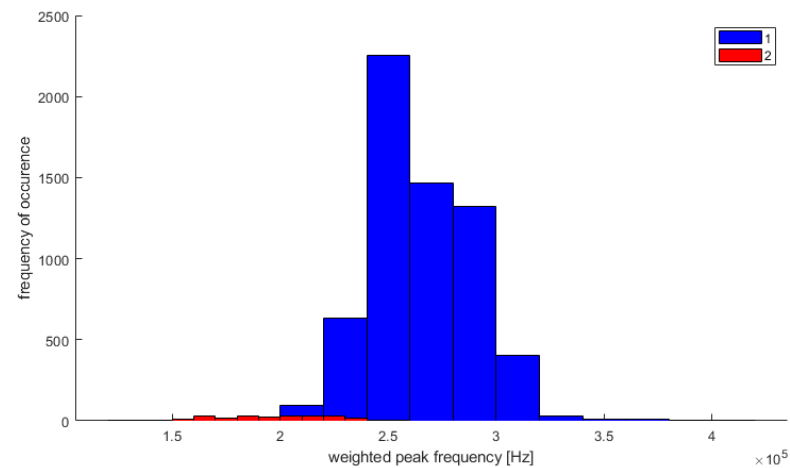
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Sealant (adapter plate): Mica
Clamping weight: 1 kN



Análisis de señales de emisión acústica registradas en Canal 4



Proceso de agrupamiento de los diferentes mecanismos de fractura en selladores de vidrio cerámico



Unsupervised clustering

Clustering Algorithm

- k-means
- k-medoids
- Agglomerative tree linkage
- Gaussian mixture models
- Gustafson-Kessel

Number of clusters:

Cluster algorithm

Cluster ID:

Create from plot

Seek optimal partition

Supervised clustering

ANN classifier

Noise classifier

ANN classifier

Use subset size?

Subset size:

ANN classifier

Save classifier

Detect similar signals

Feature selection

Auto feature selection

- partial power 1 [%]
- partial power 2 [%]**
- partial power 3 [%]
- partial power 4 [%]
- partial power 5 [%]
- partial power 6 [%]
- peak frequency [Hz]
- frequency centroid [Hz]

Partition data:

Number of data points 6468

Number of clusters 2

Cluster validity measures:

Davies-Bouldin Index 0.66

Calinski-Harabasz Index 199.46

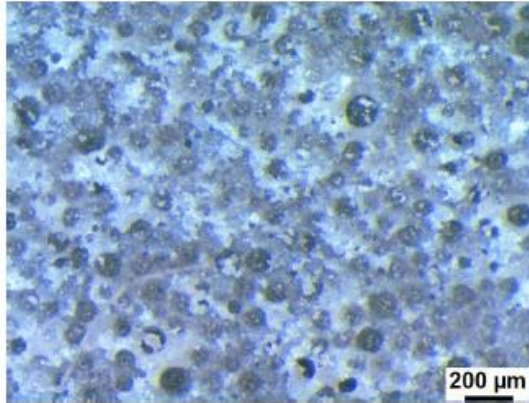
modified Hubert's Gamma 0.47

Silhouette Index 0.74

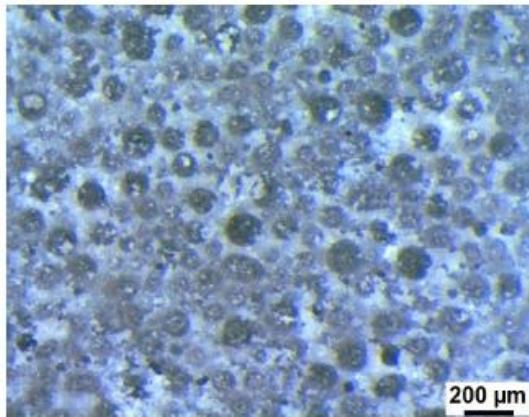
Tou Index 0.38

Uncert. of Classific. (UoC) 9.4 [%]

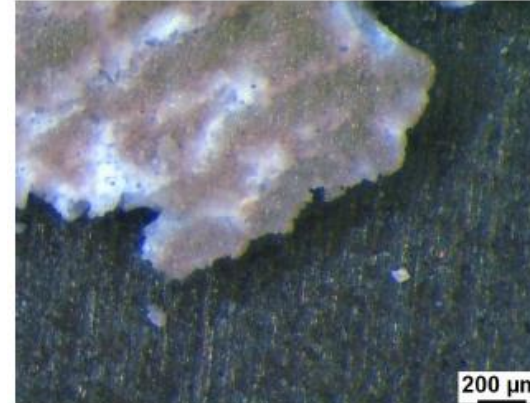
Técnica de metalografía: prueba postmortem



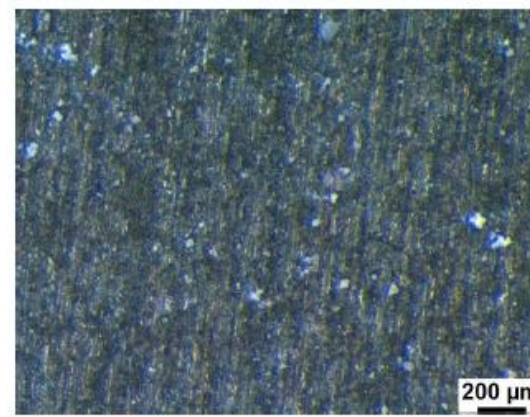
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0495_MY1004-6_750°C_00002



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Sólo la adquisición de diferentes conocimientos de la ciencia permite proponer y desarrollar proyectos interdisciplinarios.

La colaboración con expertos de diferentes temáticas (p. ej. ciencia en materiales, electrónica, acústica, mecánica, etc.) ha permitido alcanzar el avance mostrado a la fecha.



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