DEVELOPMENT OF A THERMAL/ACOUSTIC INSULATING BLANKET RESPONDING TO THE FAR 25.856 BY THE INTEGRATION OF MICA FLAME BARRIER

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1. ABSTRACT

Natural mica, which is a hazard free material, is an alumino-silicate composed of layered particles. Mica self-structuring particles form a compact oriented film called a mica paper, manufactured by Cogebi. By controlling the size and form factor of the particles, a very thin and lightweight paper is formed during a manufacturing process. This sheet can stop a flame without any other additives.
A partnership between Cogebi and Daher has allowed the integration of this flame-barrier conserving the current manufacturing process. Daher produces a new generation of blanket insulation responding to the FAR25§856 Parts a and b and the industrial constraints of the air-framer (fuselage and cockpit installation, maintainability and weight requirements). The new blanket is called CoDaX™.

2. ISSUE

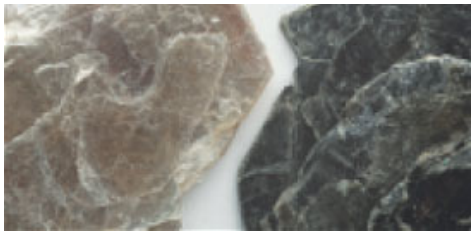
CoDaX™ development has been initiated by two issues:
First, the fuselage thermal and acoustic insulation in airplanes must fulfill the requirements of the FAR25§856 Part b from 2007. Blankets that are usually used on fuselage do not meet these requirements. Thus we were led to develop a new thermal / acoustic insulating blanket.
Additionally, this development remains in accordance with the aircraft manufacturers constraints listed hereafter:

- the surface weight of the flame barrier should not exceed 75g/m²
- the new blanket should not lead to design modification as to allow an easy retrofit
- the new process should not lead to manufacturing delay

3. MICA

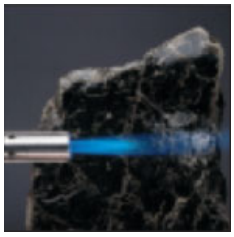
a. Mica – Raw Material

Natural mica is a mineral material in the alumino-silicate family. It can be found throughout the world, most notably in the presence of Paleozoic rocks. Accessible deposits are located primarily in India, on the American continent, in southern Africa and in Russia. Its structure is lamellar and non-fibrous.



Mica can easily be split into very thin flakes of constant thickness.

Natural mica has exceptional properties:



Mica is a flame-barrier, non-flammable and flame-retardant. It withstands temperature over 1000°C/1830°F.

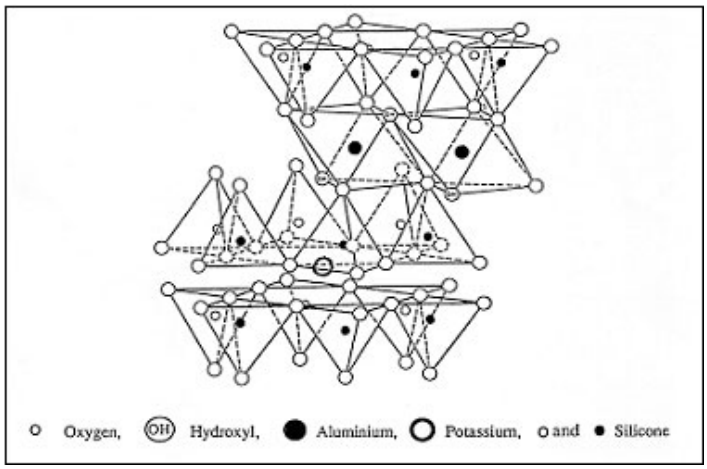
Natural mica has a dielectric strength greater than 25 kV/mm, It has good resistance to arcing and arc erosion, and it is permeable to microwaves.

Mica is inert to most chemical agents, such as solvents, acids, bases, and mineral oils.

Mica has very good compressive resistance. It has a good tensile strength, and a high modulus of elasticity.

b. Mica Paper

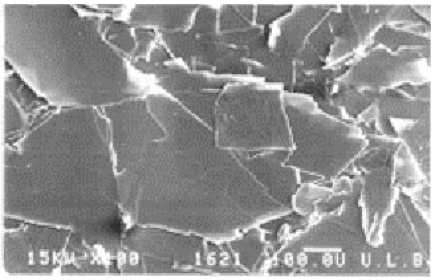
Mica is a 2:1 phyllosilicate with an octahedral layer sandwiched between two tetrahedral silicon layers as illustrated in figure. The electrical negative residual charge is compensated by Potassium ion between the TOT layers.

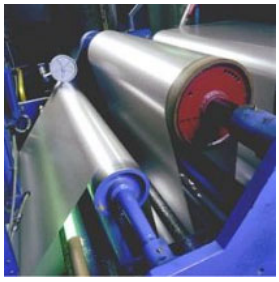


Due to its lamellar crystallographic structure, mica properties are strongly dependent on the direction of propagation (anisotropy). The most exceptional behavior of mica is exhibited in the direction perpendicular to its cleavage plane.

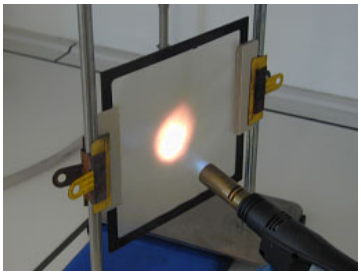
Cogebi is able to transform mica mineral into pure mica paper.
The process subjects the mineral to the action of a highly pressurized water jet, producing flat particles which are several microns thick whose physical and chemical properties have been carefully preserved. The resulting water slurry is fed to a special type of paper machine, which forms a continuous sheet of mica paper.

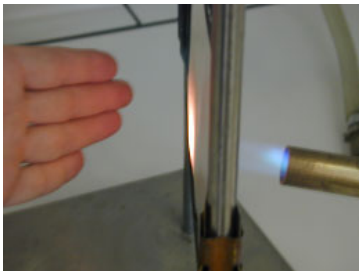
At this stage, there is no need for a binding agent to hold the particles together, because their existing natural intermolecular attraction is strong enough.





Cogebi developed an original process for the manufacture of very thin mica paper. The choice of a high particle diameter to thickness ratio, combined to the formation of a continuous sheet allows the self-orientation of the particles. That guaranties the best flame barrier behavior that mica can exhibit. A pure mica paper of 25 g/m² is already an excellent flame barrier.



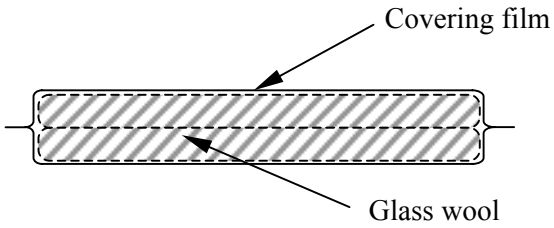


4. BLANKET

Thermo phonic insulation is the historical core business of Daher Atlantique.

The general insulation blankets constitution principle is as follows:
One or more glass wool plies are covered by a PVF or APK film.

- Glass wool provides both thermal and acoustic insulation.
- The PVF or APK film provides protection of the wool against water. It helps the product maintain its initial low weight.
- The blankets are also equipped with specific basic elements.



The blankets are engineered to perform maximum insulation in complex environments and for complex shaped parts. The covering film provides maintainability to the blanket so it can be handled many times along its lifetime: production, transport, installation, last minute adaptation…

Daher Atlantique developed its original process for the production and installation of insulation blankets:

- Raw materials automatic cutting (based on 5 automatic cutting and/or marking machines),

- Primary blankets constitution (based on the initial identification of large primary blankets families),
- Finishing and equipment of the blankets, according to the special aircraft version to be isolated (activity based on the configuration management),
- Logistics : including transport and workshop just-in-time delivery,
- Blankets installation on aircraft.

- After-sales service: refurbishing and new installation for the customer as well as for companies potentially all around the world.

The full product life activity is managed by Daher Atlantique. Engineering occurs on each of the development and production steps.

- Research and development
- Innovative materials and process engineering
- Design
- Process engineering for production and aircraft installation
- Product and service quality management

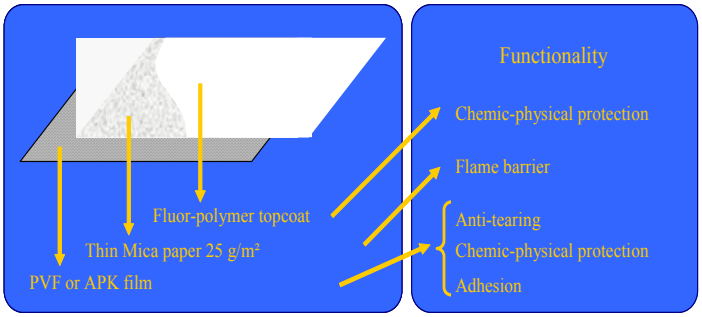
Daher produces and installs its products for each Airbus aircraft family: Wide Body, Single Aisle, Long Range and A380. Daher Atlantique is now developing to North American, South American, Russian and Asian markets.

5. NEW PRODUCT CoDaX™

a. Mica-film Co-laminate

100% mica papers are used by Cogebi as the basis for developing the range of products. The mechanical characteristics of mica papers need to be improved before they can be used in industrial applications. This is done either by impregnating or coating them with different binders and by attaching them to a backing material.

For the fuselage burnthrough resistance application, we have developed a specific product. The material consists in a layer of thin mica paper coated with a fluor-polymer and co-laminated with a film. The film, used as backing material, is the same PVF or APK film used as skin of the blanket responding to the Part (a) of the FAR 25§856. The functionality of each part of the mica-film co-laminate is the following:



- The mica paper 25 g/m² is the flame-barrier and allows passing the Burnthrough test.
- The fluor-polymer topcoat on the mica paper is a protection against hostile environment.
- The PVF or APK film is used as the blanket's skin and contributes to mechanical strength during manipulations.

The mica-film co-laminate is available in rolls for use in the classical blanket processing.

b. Tests on Mica-Film Co-laminate

Characteristics

Table 1 shows the characteristics of three kinds of mica-film co-laminate depending on the skin used. The products respect the requirements normally demanded for the skin of the blanket. The additional weight for the flame barrier property is around 40 g/m².

Properties	Unit	Test method	Target		Results Mica-PVF1	Mica-PVF2	Mica-APK
Square weight total	g/m²	EN 12127	-		67.0	73.4	63.1
Square weight flame barrier	g/m²	EN 12127	≤ 75		37.0	42.4	41.1
Thickness	mm	IEC 371-2	-		0.10	0.13	0.10
Tensile strength	N/25mm	Aircraft Manufacturer Test Method	≥ 40		47.3	42.4	52.1
Penetration strength	N	Aircraft Manufacturer Test Method	∅10mm	≥ 30	40.7	47.6	37.2
			∅20mm	≥ 65	76.7	96.8	66.8
Peeling	N/25mm	Aircraft Manufacturer Test Method	≥ 10		13.4	18.2	19.3

Table 1

Burning behavior

The burning behavior following the regulation FAR 25§853 is presented in tables 2 and 3. The mica is naturally a non-flammable material and then, the burn length only affects the PVF film. The results in the vertical test room are excellent and no smoke is released within 4 minutes of test.

Burning behaviour: FAR 25§853 Appendix F, part I (a) (I) (ii)

Flammability vertical 12 s	**Unit**	**Requirements**	**Results Mica-PVF1**
Burn length	mm	≤ 203	**142**
After flame time	s	≤ 15	**0**
After flame time of drips	s	≤ 5	**No drip**

Table 2

Maximal specific optical smoke density within 4 min: FAR 25§853 Appendix F, part V (d)

	Unit	**Requirements**	**Results Mica-PVF1**
Flaming mode	-	≤ 100	**0**
Non flaming mode	-	≤ 100	**0**

Table 3

There is no release of hydrogen chloride, sulfur dioxide, hydrogen cyanide or nitrous gases. The hydrogen fluoride detected by ionic chromatography during the flaming test is less than the detection limit of 10 ppm (Table 4).

Gas	**Unit**	**Requirements**	**Results non-flaming test Mica-PVF1**	**Results flaming test Mica-PVF1**
Hydrogen fluoride HF	ppm	≤ 100	**0.0**	**< 10**
Hydrogen chloride HCl	ppm	≤ 150	**0.0**	**0.0**
Sulfur dioxide H2S + SO2	ppm	≤ 100	**0.0**	**0.0**
Hydrogen Cyanide HCN	ppm	≤ 150	**0.0**	**0.0**
Carbon Monoxide CO	ppm	≤ 1000	**0.0**	**63.3**
Nitrous gases NO + NO2	ppm	≤ 100	**0.0**	**0.0**

Table 4

Aging tests

We are testing the mica-film co-laminate after exposure to dry heat and after exposure to hot and wet. The tests are in progress and the first results are presented in table 5.

Properties	Unit	Test method	Requirements	Results 1000h/70°C Mica-PVF1	Results 1000h/70°C/98%RH Mica-PVF1
% change of tensile strength	%	Aircraft Manufacturer Test Method	25	24	9
% change of seam resistance - peeling	%	Aircraft Manufacturer Test Method	30	15	5

Table 5

c. CoDaX™ qualification

Burning behavior

The blanket CoDaX™ was tested in accordance to the FAR 25§853 (a) regulation i.e. the burning behaviour in the vertical test during 12 seconds. The results are excellent with only 28 mm burn length whereas the requirement is maximum 203 mm. No flame persists and no drip during the test (Table 6).

	Unit	Requirements	CoDaX™
Burn length	mm	< 203	28.3
After flame time	s	< 15	0
After flame time of drips	s	< 5	No drip

Table 6

Flame propagation

CoDaX™ successfully passes the new requirement FAR 25§856 part (a) about the flame propagation. The flame extinguished immediately, flame time is zero and in consequence no flame propagation distance (Table 7)

Radiant panel test	Unit	Requirements	CoDaX™
Flame time	s	< 3	0
Flame propagation distance	mm	< 51	-

Table 7

Burnthrough

The requirement introduced by the FAR 25§856 Part (b) is the ability of the thermal/acoustic insulation to resist penetration by an external flame for at least 4 minutes (Burnthrough). The maximum flux measured behind 305 mm from the front of the test rig is 2.27 W/cm² (< 2.0 BTU/ft².sec)

The blanket CoDaX™ successfully passes the tests as required by the FAR 25§856 Part (b) and the results are presented in table 8. CoDaX™ has shown its ability to resist burnthrough for at least 5 minutes.

CoDaX™ results:	
No flame penetration	
Backface calorimeters	0.89 and 0.58 W/cm²

Table 8

The pictures below shows the burnthrough test in progress and the blanket CoDaX™ after test.

6. CONCLUSION

The partnership between DAHER and COGEBI allowed the development of a new product. This new fuselage thermo phonic insulation blanket makes it possible to present a product in line with the initial objectives/goals of the project.

- Fire behavior following the existing requirements (flammability, flame propagation)
- Response for the future requirement: no burnthrough.
- Lightness of the fire barrier (40 g/m²)
- Integration of the fire barrier function in the blanket and thus no new parts must be managed.
- Conservation of the blanket suppleness

Using CODAX™ products doesn't modify the assembly on aircraft (a retrofit of the blanket is possible without adaptation of the CODAX™ product).
The co-laminate mica-film used for the CODAX™ blanket is made of by industrial process.
The manufacturing of the CODAX™ by DAHER uses only existing industrial resources and processes and doesn't require heavy adaptation:

- The joining of 2 films of covering can be realized by ultrasonic welding.
- If necessary the co-laminate (and then the fire barrier) can be stitched with ceramic yarn and the fireproof function is maintained.

Before the qualification on aircraft, several focuses must be treated.
These points will require a complement of study:

- To check the reproducibility of the product for a larger manufacturing
- To validate the vibratory resistance and to validate the inspectability and the maintainability of the CODAX™ in operational conditions.