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## OUTGASSING TEST OF CABLING WITH PYRE-ML INSULATION

Code:  
VIR-TRE-PIS-3400-115

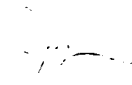
Date: 21/04/1997


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### CHANGE RECORD


<i>Issue/Rev</i>	<i>Date</i>	<i>Section affected</i>	<i>Reason/ remarks</i>

<b>Authors:</b>	<b>Date</b>	<b>Signature</b>
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<b>Approved by:</b>		

 The logo for VIRGO, featuring a stylized representation of a spiral or wave pattern above the word "VIRGO" in a bold, sans-serif font.	Pyre-ML cabling	Doc: VIR-TRE-PIS-3400-115 code Issue: 1 Date: 21/04/1997 Page: 3
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In this note we briefly report the results obtained with Pyre-ML cabling. The measurement method is described in detail in VACPISA 025.

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## 1 - System performances

We performed a baking of the test chamber at 250 °C for 77 hours and we got:

t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
after	33	3.6x10 <sup>-9</sup>	2.7x10 <sup>-9</sup>	1.8x10 <sup>-8</sup>

The main components of outgassing after baking were H<sub>2</sub>, H<sub>2</sub>O, N<sub>2</sub>/CO, CO<sub>2</sub>. The internal surface of the chamber is 2500 cm<sup>2</sup>.

## 2 - Measurement of the outgassing flow of Pyre-ML insulation cabling

The experimental sample consisted of 25 m of 0.1 mm diameter cable with Pyre-ML wire enamel insulation manufactured by California Fine Wire and purchased via Corradi, Italy. Pyre-ML is a Dupont trademark based on aromatic polyimides which is used for thermocouple insulation and for sealed relays to be used in vacuum. The total resistance of cabling was 55 Ω. The exposed surface of cabling was 78.5 cm<sup>2</sup>. The cables were cleaned in an ultrasonic bath of isopropyl alcohol for 15 minutes then baked in air at 100 °C for four days.

We monitored the evolution of outgassing (time is measured from beginning of the test through the whole paper):

t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
65	25	1.9x10 <sup>-7</sup>	8.0x10 <sup>-8</sup>	2.2x10 <sup>-6</sup>
89.5	25	1.4x10 <sup>-7</sup>	3.4x10 <sup>-8</sup>	2.1x10 <sup>-6</sup>
118.5	23	1.3x10 <sup>-8</sup>	6.2x10 <sup>-9</sup>	1.4x10 <sup>-7</sup>
139	25	1.1x10 <sup>-8</sup>	5.2x10 <sup>-9</sup>	1.2x10 <sup>-7</sup>
144	25	1.0x10 <sup>-8</sup>	5.2x10 <sup>-9</sup>	9.6x10 <sup>-8</sup>
209.5	25	6.8x10 <sup>-9</sup>	3.7x10 <sup>-9</sup>	4.6x10 <sup>-8</sup>
234	23	9.5x10 <sup>-9</sup>	8.5x10 <sup>-9</sup>	2.0x10 <sup>-8</sup>
261	33	4.3x10 <sup>-9</sup>	2.5x10 <sup>-9</sup>	3.6x10 <sup>-8</sup>

The spectrum taken after 261 hours is shown in Fig. 1.

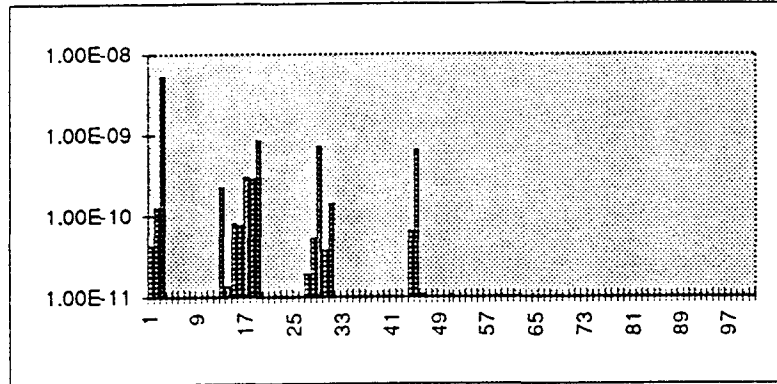


Fig. 1 Outgassing spectrum after 261 hours pumping at room temperature

We set temperature to 60 °C and monitored the evolution of outgassing:

t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
261.75	43	5.0x10 <sup>-6</sup>	5.7x10 <sup>-7</sup>	8.9x10 <sup>-5</sup>
262	65	1.0x10 <sup>-6</sup>	2.1x10 <sup>-7</sup>	1.6x10 <sup>-5</sup>
280.5	60	6.1x10 <sup>-8</sup>	2.1x10 <sup>-8</sup>	8.0x10 <sup>-7</sup>
287	60	4.1x10 <sup>-8</sup>	1.2x10 <sup>-8</sup>	5.8x10 <sup>-7</sup>
305	60	3.4x10 <sup>-8</sup>	1.1x10 <sup>-8</sup>	4.6x10 <sup>-7</sup>
309.5	60	3.0x10 <sup>-8</sup>	1.2x10 <sup>-8</sup>	3.6x10 <sup>-7</sup>

The spectrum measured after 262 hours is shown in Fig. 2.

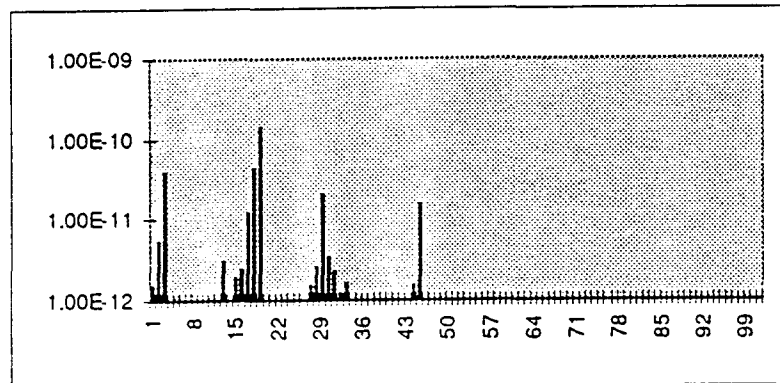


Fig. 2 Outgassing spectrum during heating at 50 °C

We set the temperature at 100 °C and we measured:



t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
309.75	75	4.1x10 <sup>-6</sup>	4.9x10 <sup>-7</sup>	7.2x10 <sup>-5</sup>
310.25	110	1.5x10 <sup>-5</sup>	2.2x10 <sup>-6</sup>	2.6x10 <sup>-4</sup>
311.5	105	1.9x10 <sup>-6</sup>	3.2x10 <sup>-7</sup>	3.2x10 <sup>-5</sup>
377.5	100	7.3x10 <sup>-8</sup>	2.2x10 <sup>-8</sup>	1.0x10 <sup>-6</sup>
382.5	100	6.4x10 <sup>-8</sup>	2.1x10 <sup>-8</sup>	8.6x10 <sup>-7</sup>

The spectrum measured after 382.5 hours is shown in Fig. 3.

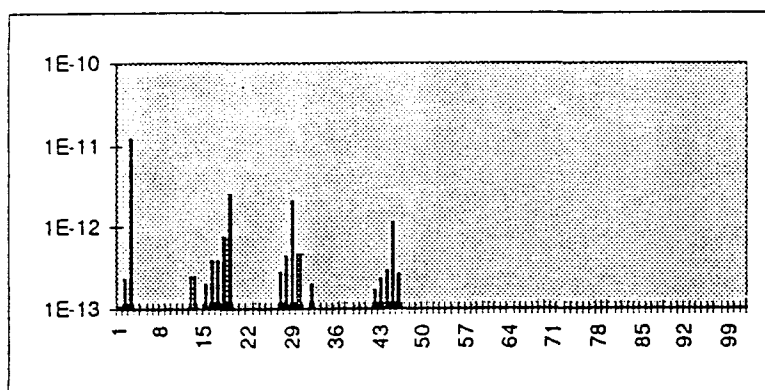


Fig. 3 Outgassing spectrum after 78 hours at 100 °C

We set temperature to 150 °C and we measured:

t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
382.75	120	5.4x10 <sup>-7</sup>	7.0x10 <sup>-8</sup>	9.4x10 <sup>-6</sup>
383.25	150	9.5x10 <sup>-6</sup>	1.4x10 <sup>-6</sup>	1.6x10 <sup>-4</sup>
385	150	1.8x10 <sup>-6</sup>	3.3x10 <sup>-7</sup>	2.9x10 <sup>-5</sup>
401	150	2.7x10 <sup>-7</sup>	8.3x10 <sup>-8</sup>	3.7x10 <sup>-6</sup>
407	150	2.2x10 <sup>-7</sup>	7.0x10 <sup>-8</sup>	3.0x10 <sup>-6</sup>

In the morning we found the pump off and an outgassing level 3.5 times higher; no air entered in the system and in half an hour the vacuum came back to the above level.

473	150	7.1x10 <sup>-8</sup>	3.6x10 <sup>-8</sup>	7.0x10 <sup>-7</sup>
479.75	150	9.7x10 <sup>-8</sup>	4.2x10 <sup>-8</sup>	1.1x10 <sup>-6</sup>

The spectrum measured after 479.75 hours is shown in Fig. 4.

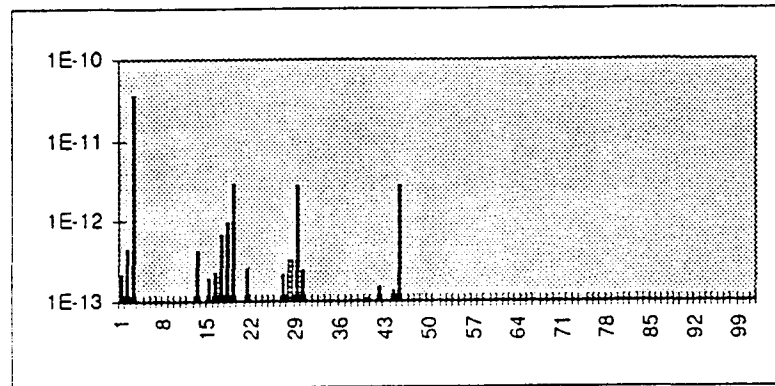


Fig. 4 Outgassing spectrum after 97 hours at 150 °C

We switched off the heating and we measured:

t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
480.25	85	3.1x10 <sup>-8</sup>	2.4x10 <sup>-8</sup>	1.4x10 <sup>-7</sup>
480.75	65	2.0x10 <sup>-8</sup>	1.6x10 <sup>-8</sup>	8.0x10 <sup>-8</sup>
547.5	25	8.4x10 <sup>-10</sup>	5.0x10 <sup>-10</sup>	6.8x10 <sup>-9</sup>
550	25	1.0x10 <sup>-9</sup>	6.7x10 <sup>-10</sup>	6.6x10 <sup>-9</sup>

The spectrum measured after 550 hours is shown in Fig. 5.

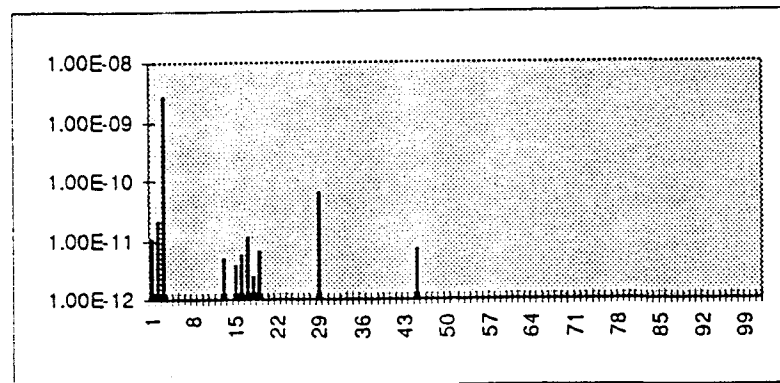


Fig. 5 Outgassing spectrum after vacuum baking at 150 °C



We tested the cables with current flowing. We operated at a couple of W dissipation for two days with a small increase in outgassing. A short test around 10 W dissipation caused an increase of less than order of magnitude in the outgassing.

The outgassing rate evolution is summarized in Fig. 6.

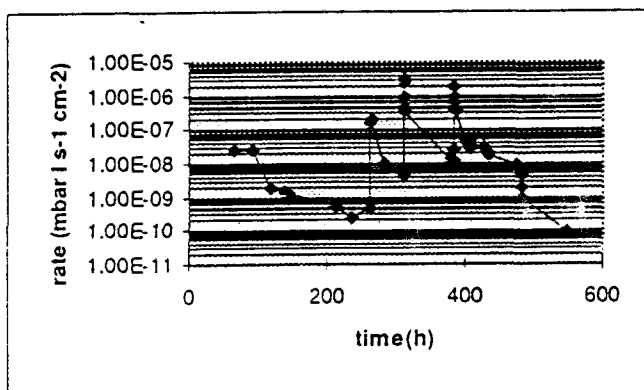


Fig. 6 Time evolution of the outgassing rate

### 3 - Discussion

The outgassing rate of the cabling after baking at 150 °C was  $\sim 10^{-10}$  mbar l s<sup>-1</sup>cm<sup>-2</sup>. We tested the cabling at 50, 100, 150 °C and we did not observe any sizable organic contamination. This kind of cabling can be recommended for VIRGO. In the context of our collaboration, GEO600 is investigating the possibility to prepare encapsulated coils using glass bonding techniques. This type of insulation is able in fact to tolerate transient exposures to temperature of a few hundreds °C.