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OUTGASSING TEST OF SOME LEMO
CONNECTORS WITH PEEK
INSULATION

Code:
VIR-TRE-PIS-3400-138

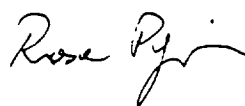
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Date: 16/01/1999

	<p>Lemo connectors with PEEK insulation</p>	<p>Doc: VIR-TRE-PIS-3400-138 code Issue: 1 Date: 16/01/1999 Page: 2</p>
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CHANGE RECORD

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

<p>Authors: M. Bernardini H. B. Pan R. Poggiani</p>	<p>Date</p>	<p>Signature </p>
<p>Approved by:</p>		



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In this note we briefly report the outgassing measurement of some LEMO electrical connectors with PEEK insulation. The measurement method is described in detail in VACPISA 025.

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1 - System performances

The typical base pressure of the test chamber after a baking at 250 °C for several days is $\sim 10^{-10}$ mbar, with an outgassing rate of the order of $\sim 10^{-12}$ mbar l s⁻¹ cm⁻².

The main components of outgassing after baking are H₂, H₂O, N₂/CO, CO₂. The internal surface of the chamber is 2500 cm².

2 - Measurement of the outgassing flow of LEMO connectors

The experimental samples were 6 multi-pin electrical connectors with PEEK insulation manufactured by LEMO. The connectors were cleaned using an ultrasound bath of isopropyl alcohol for 20 minutes and a few hours baking in air at 100 °C.

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

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
18	21	5.4x10 ⁻⁷	1.5x10 ⁻⁷	7.8x10 ⁻⁶
24	22	3.1x10 ⁻⁷	7.3x10 ⁻⁸	4.7x10 ⁻⁶
41.2	20	2.5x10 ⁻⁷	4.6x10 ⁻⁸	4.1x10 ⁻⁶
48.4	23	2.2x10 ⁻⁷	4.1x10 ⁻⁸	3.6x10 ⁻⁶
114.5	21	1.8x10 ⁻⁷	5.2x10 ⁻⁸	2.6x10 ⁻⁶
117.7	22	1.3x10 ⁻⁷	3.3x10 ⁻⁸	1.9x10 ⁻⁶
138.8	21	1.5x10 ⁻⁷	4.8x10 ⁻⁸	2.0x10 ⁻⁶

A mass spectrum measured at room temperature is shown in Fig. 1.

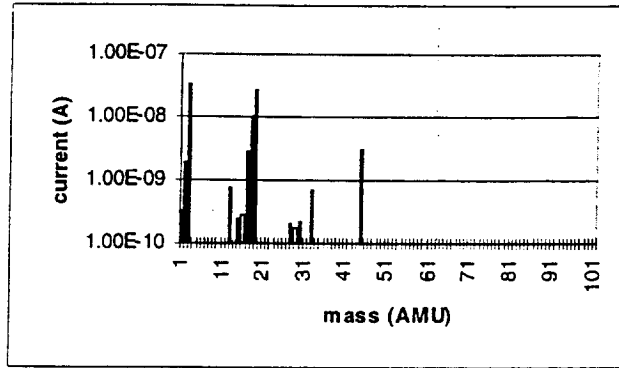


Fig. 1 Outgassing spectrum during pumping at room temperature

We set temperature at 50 °C for 143 hours and monitored the evolution of outgassing:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
139.8	63	5.4x10 ⁻⁷	1.3x10 ⁻⁷	8.2x10 ⁻⁶
145.4	55	4.6x10 ⁻⁷	1.0x10 ⁻⁷	7.2x10 ⁻⁶
161.9	54	2.8x10 ⁻⁷	5.6x10 ⁻⁸	4.5x10 ⁻⁶
186.4	53	1.5x10 ⁻⁷	3.1x10 ⁻⁸	2.4x10 ⁻⁶
282.3	55	5.9x10 ⁻⁸	1.9x10 ⁻⁸	8.0x10 ⁻⁷

The mass spectrum at beginning of heating at 50 °C is shown in Fig. 2.

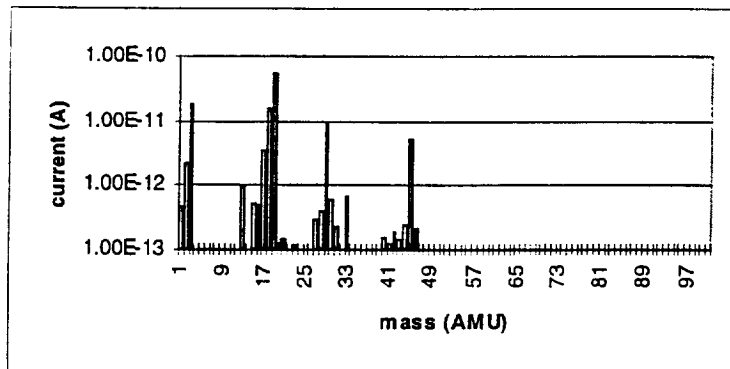


Fig. 2 Outgassing spectrum at beginning of heating at 50 °C

The mass spectrum after 143 hours of heating at 50 °C is shown in Fig. 3.

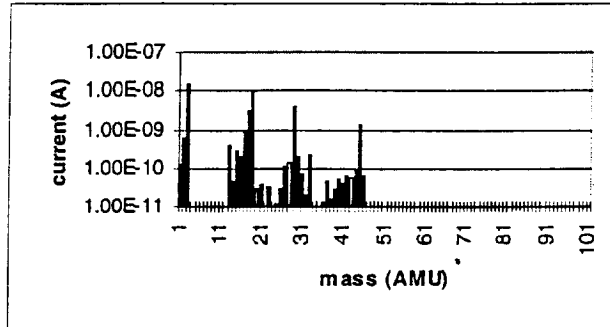


Fig. 3 Outgassing spectrum after 143 hours at 50 °C

We set temperature at 100 °C for 167 hours and monitored the evolution of outgassing:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
282.4	57	8.5x10 ⁻⁸	2.1x10 ⁻⁸	1.3x10 ⁻⁶
282.5	75	1.5x10 ⁻⁶	1.2x10 ⁻⁷	2.8x10 ⁻⁵
282.6	108	7.0x10 ⁻⁶	5.3x10 ⁻⁷	1.3x10 ⁻⁴
282.7	106	2.0x10 ⁻⁶	2.4x10 ⁻⁷	3.5x10 ⁻⁵
283.1	102	3.3x10 ⁻⁷	9.5x10 ⁻⁸	4.7x10 ⁻⁶
283.3	95	2.8x10 ⁻⁷	8.7x10 ⁻⁸	3.9x10 ⁻⁶
287.2	96	3.6x10 ⁻⁷	6.6x10 ⁻⁸	5.9x10 ⁻⁶
288.4	101	3.3x10 ⁻⁷	9.4x10 ⁻⁸	4.7x10 ⁻⁶
353.1	106	1.0x10 ⁻⁷	2.6x10 ⁻⁸	1.5x10 ⁻⁶
355.7	96	7.8x10 ⁻⁸	4.5x10 ⁻⁸	6.6x10 ⁻⁷
376.9	96	3.4x10 ⁻⁸	1.6x10 ⁻⁸	3.6x10 ⁻⁷
384.9	97	2.5x10 ⁻⁸	1.0x10 ⁻⁸	3.0x10 ⁻⁷
449.2	109	4.5x10 ⁻⁸	1.4x10 ⁻⁸	6.2x10 ⁻⁷

The mass spectrum at beginning of heating at 100 °C is shown in Fig. 4.

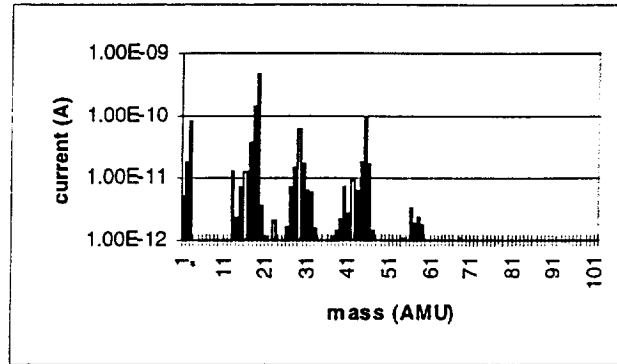


Fig. 4 Outgassing spectrum at beginning of heating at 100 °C

Some fragments at 41, 43, 45, 55 AMU, which were not very evident at 50 °C, became clearly visible, an indication of organic contamination.

The fragments are still present after 95 hours at 100 °C (Fig. 5).

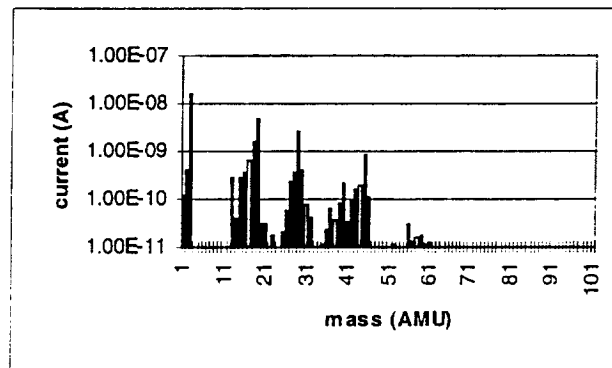



Fig. 5 Outgassing spectrum after 95 hours at 100 °C

We set temperature at 150 °C for 218 hours and monitored the evolution of outgassing:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
449.4	116	9.0x10 ⁻⁸	1.3x10 ⁻⁸	1.5x10 ⁻⁶
449.5	151	3.9x10 ⁻⁶	3.0x10 ⁻⁷	7.2x10 ⁻⁵
449.8	156	2.9x10 ⁻⁷	6.2x10 ⁻⁸	4.6x10 ⁻⁶
449.9	149	2.3x10 ⁻⁷	5.5x10 ⁻⁸	3.5x10 ⁻⁶
450.1	152	6.7x10 ⁻⁷	9.6x10 ⁻⁸	1.2x10 ⁻⁵

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450.3	165	5.8×10^{-7}	9.7×10^{-8}	9.7×10^{-6}
450.5	145	3.5×10^{-7}	7.3×10^{-8}	5.5×10^{-6}
450.8	162	7.1×10^{-7}	1.1×10^{-7}	1.2×10^{-5}
456.8	151	3.6×10^{-7}	9.2×10^{-8}	5.4×10^{-6}
474.5	148	1.8×10^{-7}	4.5×10^{-8}	2.7×10^{-6}
481.3	157	1.5×10^{-7}	3.9×10^{-8}	2.2×10^{-6}
499.8	146	9.3×10^{-8}	3.1×10^{-8}	1.2×10^{-6}
500.9	146	1.2×10^{-7}	3.6×10^{-8}	1.7×10^{-6}
521.2	146	1.4×10^{-7}	3.8×10^{-8}	2.0×10^{-6}
551.1	149	1.2×10^{-7}	3.2×10^{-8}	1.8×10^{-6}
617.4	150	1.1×10^{-7}	3.1×10^{-8}	1.6×10^{-6}
641.4	160	4.4×10^{-8}	1.7×10^{-8}	5.4×10^{-7}
667.4	153	5.3×10^{-8}	1.8×10^{-8}	7.0×10^{-7}

The mass spectrum measured at beginning of heating at 150 °C is shown in Fig. 6.

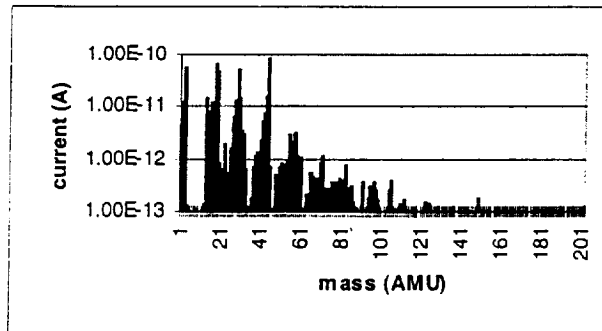


Fig. 6 Outgassing spectrum at beginning of heating at 150 °C

We clearly observed the peak clusters centred at masses multiple of 14 AMU, typical of organic contamination. There were still some fragments after 218 hours at 150 °C (Fig. 7).

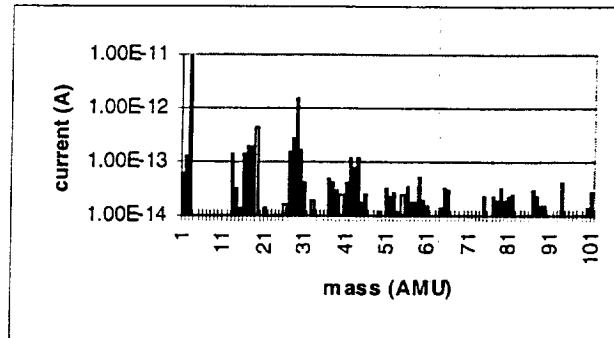


Fig. 7 Outgassing spectrum after 218 hours at 150 °C

We switched off the heating and we measured:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
691.9	38	7.1x10 ⁻⁹	5.2x10 ⁻⁹	3.8x10 ⁻⁸
693.9	16	3.6x10 ⁻⁹	3.1x10 ⁻⁹	1.0x10 ⁻⁸
712.4	13	2.7x10 ⁻⁹	2.3x10 ⁻⁹	8.0x10 ⁻⁹

The mass spectrum at 850.8 hours is shown in Fig. 8.

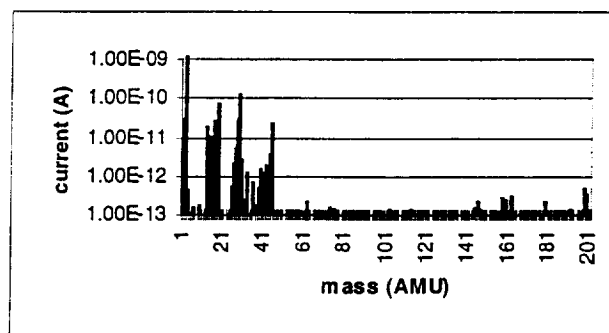


Fig. 8 Outgassing spectrum after the first thermal cycle

Since some organic contamination appeared at all stages of heating, we checked if the thermal cycle had been effective to remove them. We heated the samples at 80 °C for 187.5 hours:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
861.9	46	5.4x10 ⁻⁹	2.6x10 ⁻⁹	5.6x10 ⁻⁸
862.0	76	7.8x10 ⁻⁹	3.0x10 ⁻⁹	9.6x10 ⁻⁸



863.1	86	4.0×10^{-8}	1.8×10^{-8}	4.4×10^{-7}
863.2	84	2.4×10^{-8}	1.4×10^{-8}	2.0×10^{-7}
863.9	85	1.5×10^{-8}	9.6×10^{-9}	1.8×10^{-7}
888.1	85	8.8×10^{-9}	7.6×10^{-9}	2.4×10^{-8}
1001.4	81	4.3×10^{-9}	4.0×10^{-9}	6.0×10^{-9}
1049.4	79	4.1×10^{-9}	3.1×10^{-9}	2.0×10^{-8}

A spectrum taken at beginning of heating at 80 °C is shown in Fig. 9.

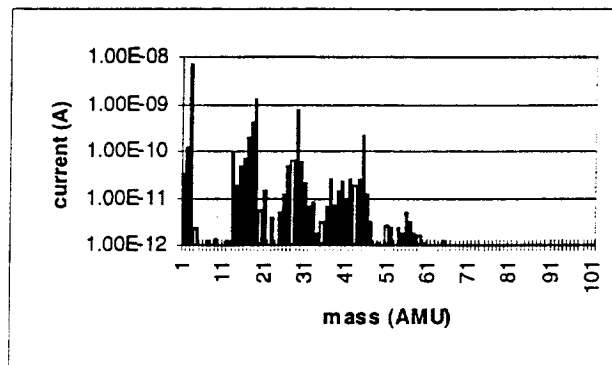


Fig. 9 Outgassing spectrum during the second heating at 80 °C

Some organic fragments appeared again.

We then heated the samples at 150 °C for 263 hours:

t(h)	T(°C)	p1(mbar)	p2(mbar)	Q(mbar l/s)
1049.7	90	4.4×10^{-9}	3.3×10^{-9}	2.2×10^{-8}
1050.9	143	3.3×10^{-8}	1.7×10^{-8}	3.2×10^{-7}
1149.7	146	5.5×10^{-8}	1.8×10^{-8}	7.4×10^{-7}
1219.2	153	4.7×10^{-8}	1.5×10^{-8}	6.4×10^{-7}
1296.3	162	3.6×10^{-8}	1.5×10^{-8}	4.2×10^{-7}
1313.1	151	3.3×10^{-8}	1.7×10^{-8}	3.2×10^{-7}

The spectrum taken at beginning of the new heating is shown in Fig. 10.

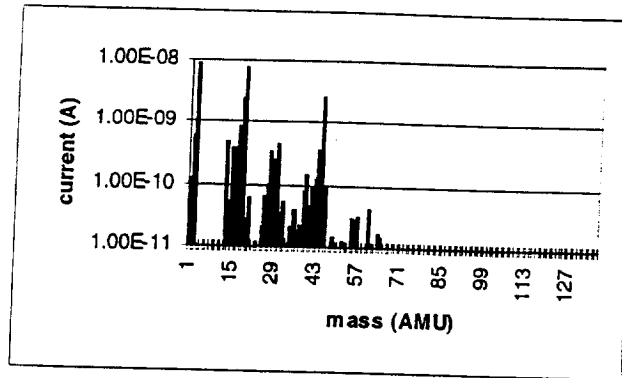


Fig. 10 Outgassing spectrum during the second heating at 150 °C

As above, some organic fragments appeared again.

We switched off heating and we measured:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
1313.9	143	3.2x10 ⁻⁸	1.9x10 ⁻⁸	2.6x10 ⁻⁷
1314.3	126	2.1x10 ⁻⁸	2.0x10 ⁻⁸	2.0x10 ⁻⁸
1320.2	58	4.1x10 ⁻⁹	3.8x10 ⁻⁹	6.0x10 ⁻⁹
1535.7	27	2.1x10 ⁻⁹	1.8x10 ⁻⁹	6.0x10 ⁻⁹

A spectrum measured after cooling down is shown in Fig. 11.

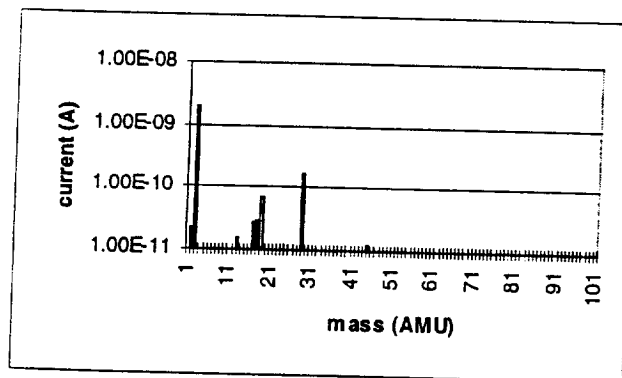


Fig. 11 Outgassing spectrum after the thermal cycles

The outgassing flow evolution is summarized in Fig. 12.

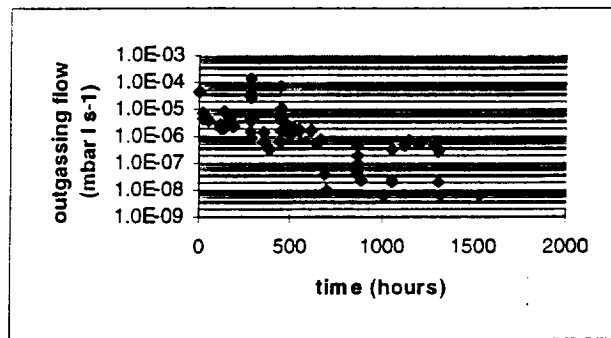


Fig. 12 Time evolution of the outgassing flow

3 - Discussion

The average outgassing flow measured for each Lemo connector after the various thermal cycles was $\sim 1 \times 10^{-9}$ mbar l s⁻¹. The various thermal cycles were not able to completely remove the organic contamination, which appeared again every time the material is heated again. We think that the contamination is coming from the intrinsic properties of PEEK material. Thus the PEEK connectors should not be baked in situ. It is worthy of note that an accurate cleaning of the connectors requires complete disassembling.