CNRS *Centre National de la Recherche Scientifique*
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OUTGASSING TEST OF "AS DELIVERED" ANTISPRING ASSEMBLIES

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Authors:	**Date**	**Signature**
M. Bernardini H. B. Pan R. Poggiani		
Approved by:		

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In this note we briefly report the outgassing measurements performed of some antispring assemblies as delivered from the factory. The measurement method is described in detail in the note VACPISA 025.

1 - System performances

The typical base pressure of the test chamber after a baking at 250 ^{0}C for several days is ~10^{-10} mbar, with an outgassing rate of the order of ~10^{-12} mbar l s^{-1} cm^{-2}.

The main components of outgassing after baking are H_2, H_2O, N_2/CO, CO_2. The internal surface of the chamber is 2500 cm^2.

2 - Measurement of the outgassing flow of antisprings

The experimental samples were two antispring assemblies each one consisting of 16 Philips Ferroxdure magnets glued with Vac-Seal vacuum epoxy to a metal support.

The purpose of the test was the check of cleaning rules in the procedures of assembling, handling and storing of the antispring assemblies and to investigate suitable conditioning procedures. The antispring assemblies were unpacked just before beginning of the test.

We first performed a conditioning step consisting of a thermal vacuum cycle up to 150 ^{0}C. a temperature which is known to be not harmful for the mechanical properties of Vac-Seal.

We quote some relevant numbers for the outgassing flow and the water content measured during this conditioning step:

After 4 days at room temperature: $Q = 4.4 \times 10^{-5}$ mbar l s^{-1}; water vapor ~53%

After 7 days at room temperature: $Q = 3.3 \times 10^{-5}$ mbar l s^{-1}; water vapor ~53%

After the thermal cycle: $Q = 1.9 \times 10^{-6}$ mbar l s^{-1}

After the thermal cycle, we vented the chamber with normal air and started the test:

t(h)	T(^{0}C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
44.1	20	2.8×10^{-7}	1.3×10^{-7}	3.0×10^{-6}
90.7	15	7.9×10^{-8}	2.1×10^{-8}	1.2×10^{-6}

In these conditions, we measured:

After 4 days at room temperature: $Q = 1.2 \times 10^{-6}$ mbar l s^{-1}; water vapor ~35%

The effect of the preliminary vacuum baking is evident when comparing these numbers with the numbers quoted above: both the outgassing flow and the water content have decreased. An outgassing spectrum at room temperature is shown in Fig. 1.

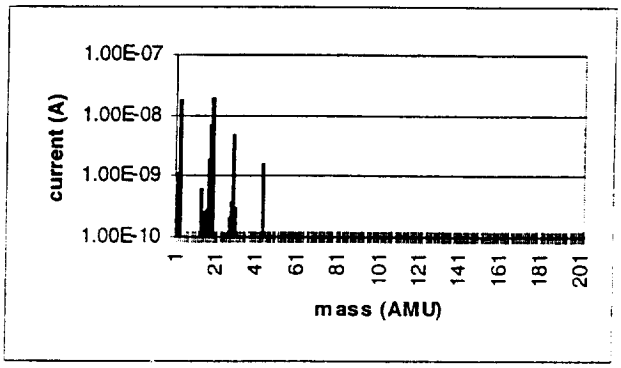

Fig. 1 Outgassing spectrum after a few days pumping at room temperature

We started heating at 80 °C for 288 hours and we measured:

t(h)	T(°C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
91.8	80	5.6×10^{-6}	5.8×10^{-7}	1.0×10^{-4}
97.2	89	1.2×10^{-6}	2.0×10^{-7}	2.0×10^{-5}
162.4	79	1.2×10^{-7}	3.2×10^{-8}	1.8×10^{-6}
192	86	9.4×10^{-8}	1.8×10^{-8}	1.5×10^{-6}
242.2	81	8.9×10^{-8}	1.7×10^{-8}	1.4×10^{-6}
263.3	84	6.7×10^{-8}	1.6×10^{-8}	1.0×10^{-6}
338.1	81	6.3×10^{-8}	1.9×10^{-8}	8.8×10^{-7}
379.4	88	4.2×10^{-8}	1.1×10^{-8}	6.2×10^{-7}

A spectrum measured during heating at 80 °C is shown in Fig. 2.

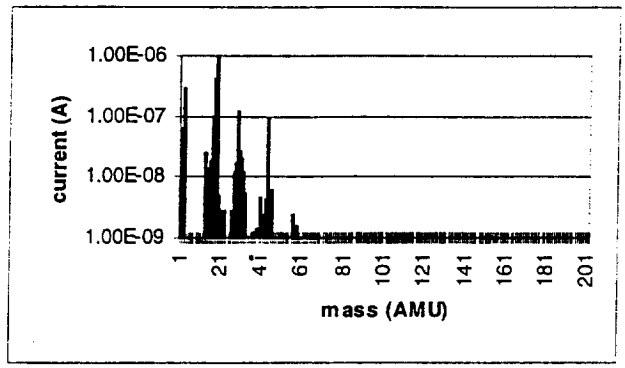

Fig. 2 Outgassing spectrum during heating at 80 °C

Some organic fragments appeared.

We then heated the samples at 150 °C for 195 hours:

t(h)	T(°C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
379.6	91	6.4×10^{-8}	1.3×10^{-8}	1.0×10^{-6}
380.2	153	2.8×10^{-7}	7.4×10^{-8}	4.1×10^{-6}
385.7	160	1.1×10^{-6}	1.6×10^{-7}	1.9×10^{-5}
409.7	149	6.4×10^{-7}	1.4×10^{-7}	1.0×10^{-5}
496.7	152	5.9×10^{-7}	9.6×10^{-8}	9.9×10^{-6}
553.6	153	5.0×10^{-7}	8.5×10^{-8}	8.3×10^{-6}
574.4	165	4.2×10^{-7}	7.0×10^{-8}	7.0×10^{-6}

The spectrum taken during the heating at 150 °C is shown in Fig. 3.

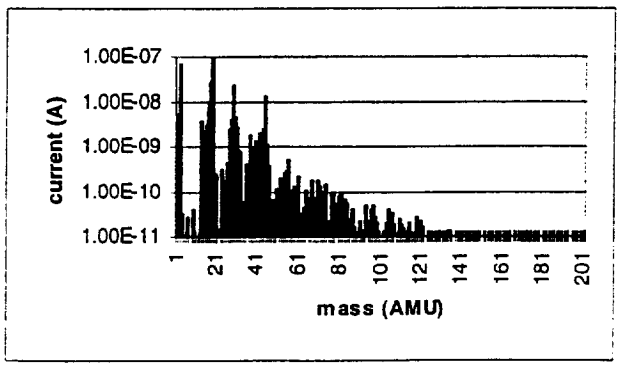

Fig. 3 Outgassing spectrum during the heating at 150 °C

Some other fragments appeared.

We switched off heating and we measured:

t(h)	T(^{0}C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
666.2	15	1.7×10^{-8}	6.4×10^{-9}	2.1×10^{-7}
739.2	16	1.4×10^{-8}	5.3×10^{-9}	1.7×10^{-7}
840.9	15	7.4×10^{-9}	3.7×10^{-9}	7.4×10^{-8}
883.3	14	6.0×10^{-9}	3.5×10^{-9}	5.0×10^{-8}

The outgassing spectrum after heating is shown in Fig. 4.

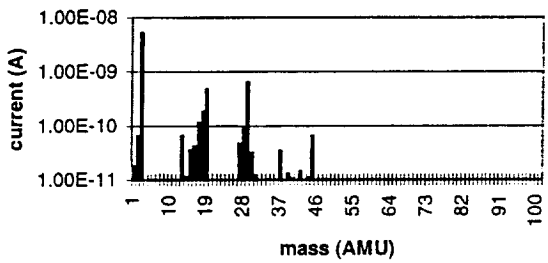

Fig. 4 Outgassing spectrum after the thermal cycle

We started a new heating at 80 ^{0}C and we measured:

t(h)	T(^{0}C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
883.9	19	7.5×10^{-9}	3.9×10^{-9}	7.2×10^{-8}
884	39	2.4×10^{-8}	5.4×10^{-9}	3.7×10^{-7}
884.1	70	4.5×10^{-8}	7.5×10^{-9}	7.5×10^{-7}
884.2	92	4.2×10^{-8}	8.0×10^{-9}	6.8×10^{-7}
885.5	80	3.2×10^{-8}	9.8×10^{-9}	4.4×10^{-7}
886.2	79	3.0×10^{-8}	1.0×10^{-8}	4.0×10^{-7}
888.8	85	3.3×10^{-8}	7.0×10^{-9}	5.2×10^{-7}
910.9	79	4.9×10^{-8}	1.1×10^{-8}	7.6×10^{-7}

913.7	89	4.3×10^{-8}	1.0×10^{-8}	6.6×10^{-7}
936.5	83	2.0×10^{-8}	6.3×10^{-9}	2.7×10^{-7}
1151.2	80	1.8×10^{-8}	7.4×10^{-9}	2.1×10^{-7}
1173.6	93	1.1×10^{-8}	4.4×10^{-9}	1.3×10^{-7}
1200.1	86	1.0×10^{-8}	5.2×10^{-9}	9.6×10^{-8}
1220.1	86	9.0×10^{-9}	4.8×10^{-9}	8.4×10^{-8}
1244	91	9.1×10^{-9}	4.8×10^{-9}	8.6×10^{-8}

An outgassing spectrum measured during the heating is shown in Fig. 5.

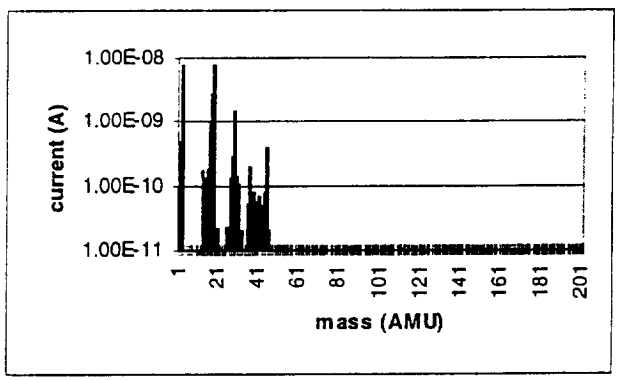

Fig. 5 Outgassing spectrum during the new heating at 80 ^{0}C

We switched off the heating and we measured:

t(h)	T(^{0}C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
1342	18	1.6×10^{-9}	1.3×10^{-9}	6.0×10^{-9}

An outgassing spectrum measured after all thermal cycles is shown in Fig. 6.

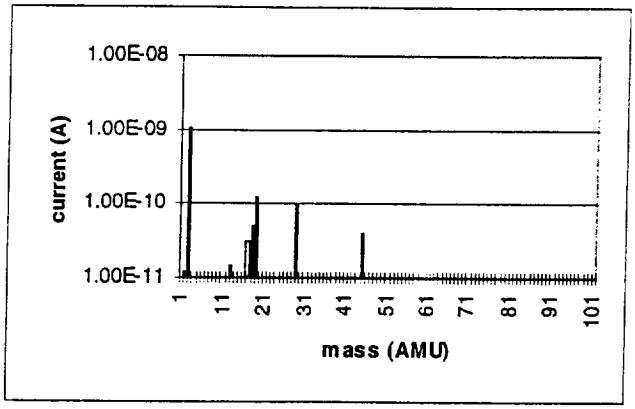

Fig. 6 Outgassing spectrum after the thermal cycles

The outgassing flow evolution is summarized in Fig. 7.

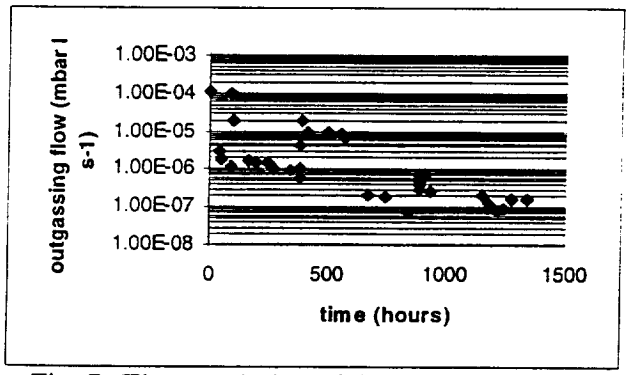

Fig. 7 Time evolution of the outgassing flow

3 - Discussion

The average outgassing flow measured for the two antispring assemblies (accounting for 32 magnets and ~32 cm^2 of Vac-Seal adhesive) after the thermal cycles described above was ~10^{-7} mbar l s^{-1} (with a water content below 10%). The organic fragments observed any time the antispring assemblies were heated are due to the intrinsic properties of Vac-

Seal itself and to a minor extent to the magnets (which are not prepared in a vacuum furnace). Thus the antisprings should not be baked in situ.

We have also shown that a preliminary vacuum baking at 150 ^{0}C is effective in reducing both the total outgassing flow and the water content.