CNRS *Centre National de la Recherche Scientifique*
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OUTGASSING TEST OF AREMCO 538 CERAMIC SEALANT

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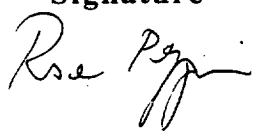
Authors:	**Date**	**Signature**
M. Bernardini H. B. Pan R. Poggiani		

Approved by:

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In this note we briefly report the outgassing measurement of the ceramic sealant Aremco 538. The measurement method is described in detail in 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 ceramic sealant

The experimental sample was the ceramic sealant 538 by Aremco. The sealant was spread on a thin metal slab, then baked for several hours in air at 100 ^{0}C both for preparation and for vacuum conditioning. The exposed surface was 195 cm^2.

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

t(h)	T(^{0}C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
25	31	2.1×10^{-5}	1.8×10^{-6}	3.8×10^{-4}
42	42	1.7×10^{-5}	1.6×10^{-6}	3.1×10^{-4}
67	35	1.3×10^{-5}	1.3×10^{-6}	2.3×10^{-4}

Due to the presence of a strong water peak, we moderately baked the sample in vacuum for a total duration of 25 hours.

t(h)	T(^{0}C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
162	25	2.7×10^{-8}	9.6×10^{-9}	3.5×10^{-7}
169	38	1.4×10^{-8}	3.1×10^{-9}	2.2×10^{-7}
186	26	8.9×10^{-9}	2.0×10^{-9}	1.4×10^{-7}

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

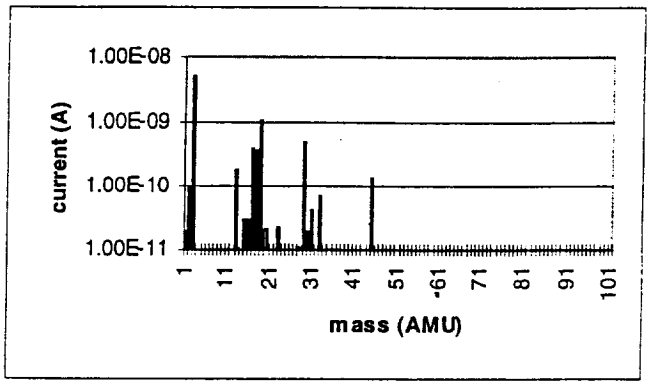

Fig. 1 Outgassing spectrum during pumping at room temperature

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

t(h)	T(^{0}C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
193	48	3.0×10^{-8}	4.2×10^{-9}	5.2×10^{-7}
194	51	3.3×10^{-8}	4.4×10^{-9}	5.7×10^{-7}
210	51	2.5×10^{-8}	3.6×10^{-9}	4.3×10^{-7}
216	50	2.0×10^{-8}	3.6×10^{-9}	3.3×10^{-7}
224	49	2.1×10^{-8}	3.1×10^{-9}	3.6×10^{-7}
258	50	2.0×10^{-8}	3.3×10^{-9}	3.3×10^{-7}
263	50	1.8×10^{-8}	3.4×10^{-9}	2.9×10^{-7}
330	50	1.4×10^{-8}	3.3×10^{-9}	2.1×10^{-7}
336	50	1.7×10^{-8}	3.5×10^{-9}	2.7×10^{-7}

The mass spectra measured at beginning and after several tens hours heating at 50 °C are shown in Fig. 2 and Fig. 3.

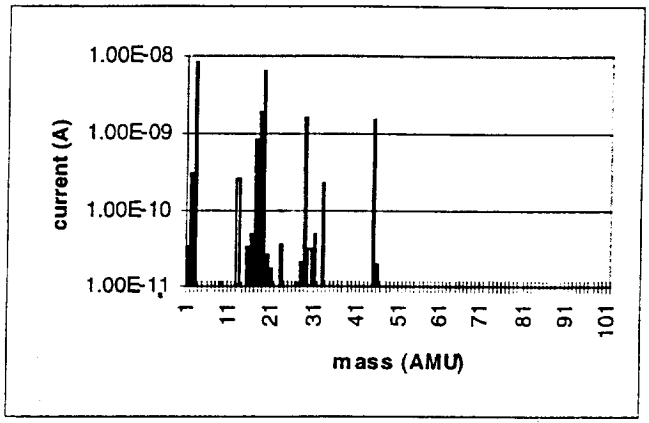

Fig. 2 Outgassing spectrum at beginning of heating at 50 °C

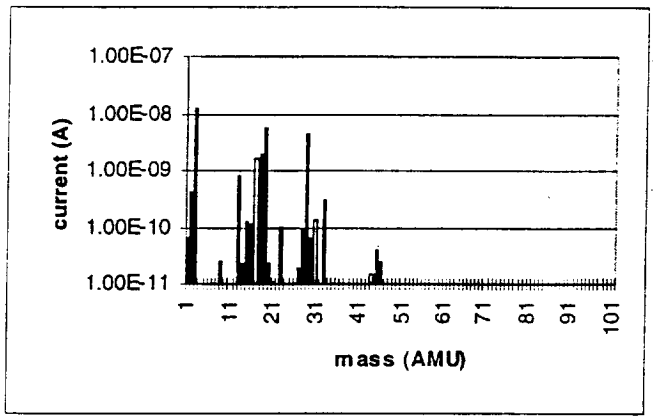

Fig. 3 Outgassing spectrum after several hours at 50 °C

We set temperature at 100 °C for 166 hours and monitored the evolution of outgassing:

t(h)	T(°C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
337	100	5.0×10^{-7}	3.4×10^{-8}	9.3×10^{-6}
338	100	6.7×10^{-7}	5.4×10^{-8}	1.2×10^{-5}
339	100	7.6×10^{-7}	6.3×10^{-8}	1.4×10^{-5}
354	100	7.3×10^{-7}	8.2×10^{-8}	1.3×10^{-5}
378	100	6.4×10^{-7}	7.8×10^{-8}	1.1×10^{-5}
382	100	4.9×10^{-7}	6.3×10^{-8}	8.5×10^{-6}
407	100	5.6×10^{-7}	7.1×10^{-8}	9.8×10^{-6}
432	100	4.9×10^{-7}	6.6×10^{-8}	8.5×10^{-6}
498	100	3.3×10^{-7}	5.8×10^{-8}	5.4×10^{-6}

503	100	3.6×10^{-7}	5.3×10^{-8}	6.1×10^{-6}

The mass spectra measured at beginning and after several tens hours heating at 100 °C are shown in Fig. 4 and Fig. 5.

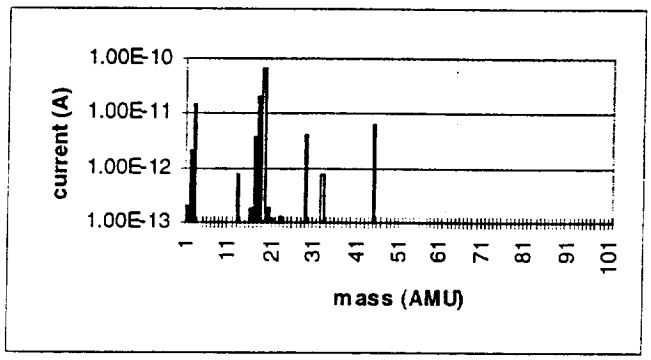

Fig. 4 Outgassing spectrum at beginning of heating at 100 °C

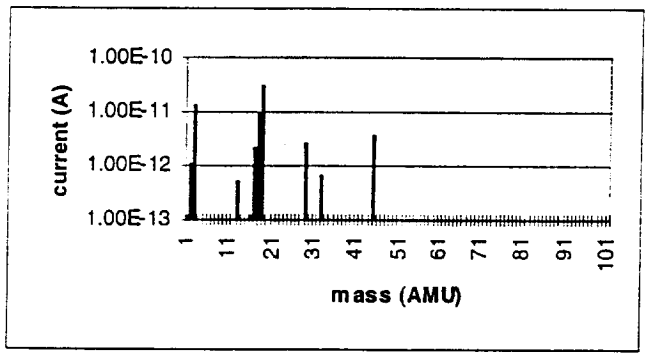

Fig. 5 Outgassing spectrum after several hours at 100 °C

We set temperature at 150 °C for 210 hours and monitored the evolution of outgassing:

t(h)	T(°C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
504	150	6.6×10^{-6}	4.5×10^{-7}	1.2×10^{-4}
505	150	1.4×10^{-5}	1.3×10^{-6}	2.5×10^{-4}

506	150	$1.7x10^{-5}$	$1.7x10^{-6}$	$3.1x10^{-4}$
507	150	$1.8x10^{-5}$	$1.8x10^{-6}$	$3.2x10^{-4}$
522	150	$8.9x10^{-6}$	$9.7x10^{-7}$	$1.6x10^{-4}$
527	150	$7.2x10^{-6}$	$7.8x10^{-8}$	$1.4x10^{-4}$
547	150	$3.1x10^{-6}$	$3.7x10^{-7}$	$5.5x10^{-5}$
575	150	$2.5x10^{-6}$	$3.4x10^{-7}$	$4.3x10^{-5}$
594	150	$2.3x10^{-6}$	$2.5x10^{-7}$	$4.1x10^{-5}$
601	151	$1.8x10^{-6}$	$2.6x10^{-7}$	$3.1x10^{-5}$
607	150	$1.2x10^{-6}$	$1.4x10^{-7}$	$2.1x10^{-5}$
692	150	$1.2x10^{-6}$	$1.5x10^{-7}$	$2.1x10^{-5}$
696	150	$1.1x10^{-6}$	$1.5x10^{-7}$	$1.9x10^{-5}$
714	150	$8.3x10^{-7}$	$1.0x10^{-7}$	$1.5x10^{-5}$

The mass spectra measured at beginning and after several tens hours heating at 150 °C are shown in Fig. 6 and Fig. 7.

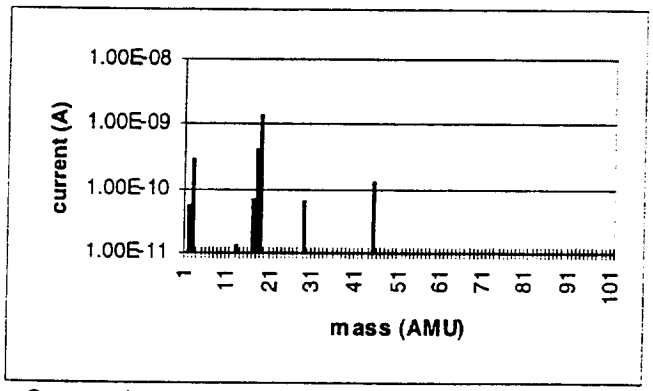

Fig. 6 Outgassing spectrum at beginning of heating at 150 °C

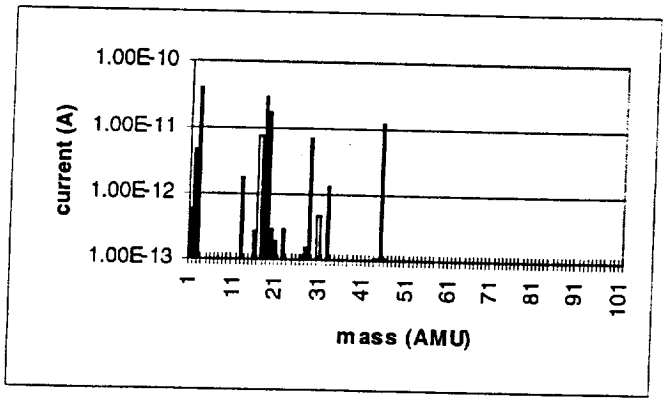

Fig. 7 Outgassing spectrum after several tens hours at 150 °C

We switched off the heating and we measured:

t(h)	T(°C)	p_1(mbar)	p_2(mbar)	Q(mbar l/s)
717	140	6.6×10^{-7}	1.0×10^{-7}	1.1×10^{-5}
722	48	1.0×10^{-8}	7.3×10^{-9}	5.4×10^{-8}
741	32	4.7×10^{-9}	4.3×10^{-9}	8.0×10^{-9}
764	30	7.7×10^{-9}	4.2×10^{-9}	7.0×10^{-8}
771	31	5.4×10^{-9}	4.1×10^{-9}	2.6×10^{-8}
786	23	5.0×10^{-9}	3.0×10^{-9}	4.0×10^{-8}
818	25	5.9×10^{-9}	3.6×10^{-9}	4.6×10^{-8}
836	29	3.6×10^{-9}	3.4×10^{-9}	4.0×10^{-9}
841	33	3.3×10^{-9}	3.0×10^{-9}	6.0×10^{-9}
858	33	3.4×10^{-9}	2.3×10^{-9}	2.2×10^{-8}
883	34	2.9×10^{-9}	2.5×10^{-9}	8.0×10^{-9}
962	27	2.5×10^{-9}	2.2×10^{-9}	6.0×10^{-9}
984	22	2.9×10^{-9}	2.6×10^{-9}	6.0×10^{-9}
1004	25	2.8×10^{-9}	2.1×10^{-9}	1.4×10^{-8}
1026	25	3.2×10^{-9}	2.4×10^{-9}	1.6×10^{-8}

The mass spectra measured after the thermal cycle is shown in Fig. 8.

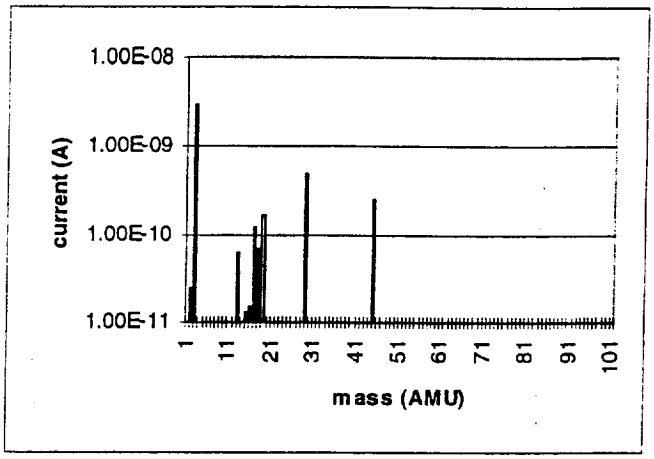

Fig. 8 Outgassing spectrum after the thermal cycle

The outgassing rate evolution is summarized in Fig. 9.

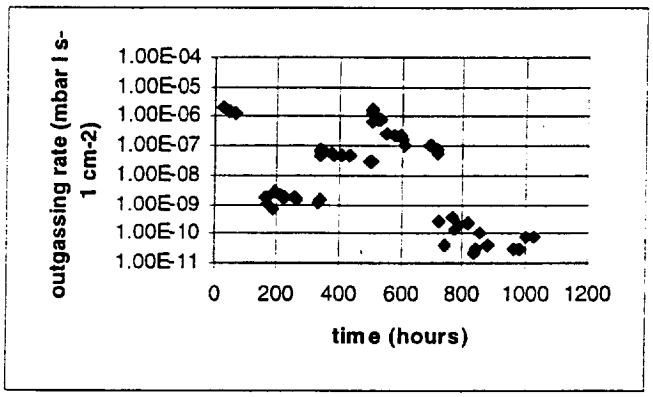

Fig. 9 Time evolution of the outgassing rate

3 - Discussion

The average outgassing rate was ~2×10^{-11} mbar l s^{-1} cm^{-2}. The most part of outgassing is water vapor. Due to the good outgassing properties, the material deserves further investigation for sealing of critical parts.