Department of Polymer Materials

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TEST REPORT

Evaluation of TUBALL™ MATRIX 601\602 concentrates to achieve volume resistivity below 100 Ohm*cm with targeted dosage of TUBALL™ 0.5% in high viscous LSR

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PURPOSE OF RESEARCH

Achieving the specified resistance level less than 100 Ω·cm at the targeted concentration of TUBALL™ 0.5 wt. % in LSR through MATRIX 601 and 602 concentrates in high viscous LSR.

Evaluation of physical and mechanical properties in comparison with the referent LSR base.

EXPERIMENTAL PART

1.1. TESTING

STANDARDS

Electrical resistance:

ASTM D257 – DC Resistance or Conductance of insulating materials

ASTM D991-89 – Standard Test Method for Rubber Property—Volume Resistivity Of Electrically Conductive and Antistatic Products.

Shore A Hardness:

ASTM D2240 - Standard Test Method for Rubber Property—Durometer Hardness.

Tensile parameters:

ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.

EQUIPMENT

Measurement of electrical resistivity was conducted using: a direct current source "DC POWER SUPPLY HY 5003D", a voltmeter "MNIPI B7-72", and picoammeter "MNIPI A2-4" (for low resistance below 10^6 ohm-cm - 4-point method), and teraommetr TO-3 cable (for high impedances starting at 10^4 ohm-cm - 2-point method).

Tensile properties – Shimadzu AGS-5kNXD.

Rheometric data – Rheo-line MultiFunction Auto-test.

Shore A hardness – Zwick roell digital shore hardness tester

1.2. MATERIALS

- TUBALL™ MATRIX™ 601 (10% TUBALL™, 90% PDMS)
- TUBALL™ MATRIX™ 602 (10% TUBALL™, 90% Vinyl terminated PDMS)
- Two component LSR - SQUARE® LIM 3900-30A/B (high viscosity more than 600 000 cPs)
- Cured rubber samples of LSR (dimensions of the rubber sheets 14.5×14.5×0.2 cm).

1.3. EQUIPMENT AND PREPARATION OF SAMPLES

Standard concentrates were tested (TUBALL™ MATRIX™ 601 and TUBALL™ MATRIX™ 602).

Mixing of TUBALL™ MATRIX was carried on three roll mill (Sower S-150) into Part A and Part B separately –2 cycles with the gap size between the rollers 20/10 μm, where 20 is the gap between feeding and central rolls and 10 is the gap between the central and apron rolls. Than mix compounded Part A and Part B together via three roll mill – 5 cycles with the gap size between the rollers 20/10 μm.

Sample of the compounded LSR - 100 g. Calculation of the ingredients for the each sample presented in a Table 1.

Table 1. *Calculation of the ingredients 0.5 wt.% TUBALL™*

Component	**Content (for 100 g sample)**	
	%	**Weight, g**
10 wt.% concentrates TUBALL™ MATRIX	5	5
LSR Part A	47.5	47.5
LSR Part B	47.5	47.5

The vulcanization was carried out by hot pressing in a steel polished mold with a pressure of 200 kgf / cm2 with a temperature of 180 ° C for 3 minutes.

The post-vulcanization process is not carried out according to Technical datasheet.

2. RESULTS

2.1 Electrical resistivity

To achieve the targeted resistivity with the dosage of active TUBALL content 0.5% standard MATRIX grades was tested as well as prototypes of the products based on TUBALL and silicone oils with improved electrical properties.

Targeted VR, Ω·cm	**TUBALL™ Concentrate**	**Volume resistivity, x±Δ Ω·cm**
Below 100	TUBALL™ MATRIX 601	40 ± 10
	TUBALL™ MATRIX 602	38 ± 10

Table 2. Electrical resistivity of post-cured LSR samples with 0.5 wt.% TUBALL™ - ASTM D 257

2.3 Mechanical properties

2.3.1 Shore A hardness

Sample	**Shore A Hardness, pts**
Referent LIM-3900/30 (base)	33
LIM-3900/30 5% TUBALL™ MATRIX 601	45
LIM-3900/30 5% TUBALL™ MATRIX 602	47

Table 3. Shore A hardness - ASTM D2240

2.3.2 Tensile strength

Sample	**M_{50}, MPa**	**M_{100}, MPa**	**M_{300}, MPa**	**M_{500}, MPa**	**Tensile Strength, Δ MPa**	**Elongation at break, %**
Referent LIM-3900/30 (base)	0.43	0.78	2.57	5,.1	5.98	570
LIM-3900/30 5% TUBALL™ MATRIX 601	0.74	1.11	2.63	4.87	6.71	598
LIM-3900/30 5% TUBALL™ MATRIX 602	0.80	1.22	3.10	4.61	5.11	514

Table 4. Tensile parameters - ASTM D412

CONCLUSIONS

Resistivity below 100 Ω·cm was achieved for TUBALL™ dosage 0.5% or 5 wt. % of concentrates TUBALL™ MATRIX 601 and 602.

Based on mechanical properties analysis, the following conclusions could be noted:

1) Shore A hardness for all samples increased by an average of 42% compared to the referent silicone base;

2) tensile strength for TUBALL™ MATRIX 602 is comparable or maintains with the data for the referent silicone base and increases by 12% with TUBALL™ MATRIX 601;

3) 50, 100, 300 modulus are increases by 56% on average with all TUBALL™ based products. TUBALL™ MATRIX 602 has a higher improvement effect to mechanical modulus due to vinyl content, compare to TUBALL™ MATRIX 601.

4) elongation at break for compounds remained at the level of the referent silicone with a change of less than 10%;

Please do mention that an exact impact to particular LSR type should be evaluated in experimental way.