Physical Properties of Silicone Rubber

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ROOM-TEMPERATURE-VULCANIZING (RTV) silicone rubber is a versatile material and easy to handle. The ingredients from which it is formed are thick liquids that vulcanize at room temperature within a short period of time after the catalyst is added. Depending upon the relative amounts of solid and foam ingredients, the consistency of the resultant rubber may range from a hard solid to a soft foam.

Increasingly numerous applications of silicone rubber are being made in prosthetics and orthotics; for example, in fabricating distal pads for above-knee and below-knee sockets, shoe fillers for certain types of foot amputations, finger pads for prosthetic hands, and pads for braces. The material has been used successfully in medical implants. It is also useful as an exercising medium for strengthening the hand grasp, because a wide range of compressive forces can be obtained by varying the consistency of the foam rubber.

An evaluation of the physical properties of silicone rubber made with varying proportions of ingredients was conducted at the U.S. Army Medical Biomechanical Research Laboratory. The results should enable users of this material to prepare foam specimens with predetermined characteristics to meet particular requirements. During this evaluation, samples were prepared and tested for density, compressive forces, and tear resistance. The material considered was a composition of RTV 385 solid elastomer, RTV 386 foam elastomer, and catalyst 386.[4]

EXPERIMENTAL PROCEDURES

Table 1 shows the sample formulations evaluated, the foam density of the samples, and the compression test and tear test results of the samples.

Each sample formulation is based on a 100-gram total of the elastomers plus six grams of the catalyst. The elastomers are combinations of the solid and foam components according to the weights shown in Table 1, except for the extremes (Samples 1 and 11), which are composed entirely of one or the other of the elastomers.

The samples were prepared in such manner that essentially a free rise was obtained. The dimensions were 1 3/16 in. X 1 3/16 in. X 3 3/16 in. for the samples on which density and compression observations were made. Tear test samples were 6 in. X 1 in. X 1 in.

Foam density was determined by dividing the weight of each specimen by the volume of the specimen.

Compression tests were conducted on a table model Instron Testing Machine (Fig. 1). Compressive forces were observed at 15 and 50 per cent deformation and reported as pressure in pounds per square inch (psi).

Tear tests were conducted in accordance with ASTM Method D1564-64T.[5] The test rate was 2 in. per min.

The maximum density was found to be approximately 68 lb. per cu. ft. Figure 2 shows that density increases at a higher rate when the specimen composition is more than 50 per

[1] Based upon Technical Report 6802, Project 3A014501 B71P 06 045, *Physical Properties of Silicone Foam (RTV 385/RVT 386),* U.S. Army Medical Biomechanical Research Laboratory, Walter Reed Army Medical Center, Washington, D.C. 20012, February 1968.

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[4] Material supplied by Dow Corning Corp., Midland, Mich. 48641.

[5] *Standards on Rubbers,* Part 28, American Society for Testing and Materials, April 1967.

TABLE 1. FORMULATIONS, FOAM DENSITY, COMPRESSION TEST RESULTS, AND TEAR TEST RESULTS

Sample No.	Formulation (grams)* RTV 385	RTV 386	Density (lb. per cu. ft.)	Pressure at 15 Per Cent Deformation (psi)	Pressure at 50 Per Cent Deformation (psi)	Tear Resistance (pi)
1	0	100	7.6	0.40	1.28	0.4
2	10	90	9.0	0.51	1.53	
3	20	80	10.0	0.61	1.66	0.5
4	30	70	11.4	0.84	2.42	
5	40	60	13.4	1.02	3.11	
6	50	50	15.5	1.28	4.21	0.7
7	60	40	18.6	2.04	6.63	
8	70	30	22.8	3.31	11.48	
9	80	20	29.6	5.61	28.06	1.5
10	90	10	39.6	12.76	51.00	
11	100	0	68.3	42.86	Beyond instrument range	2.0

* To the 100-gram total of elastomers, 6 grams of catalyst was added for each formulation

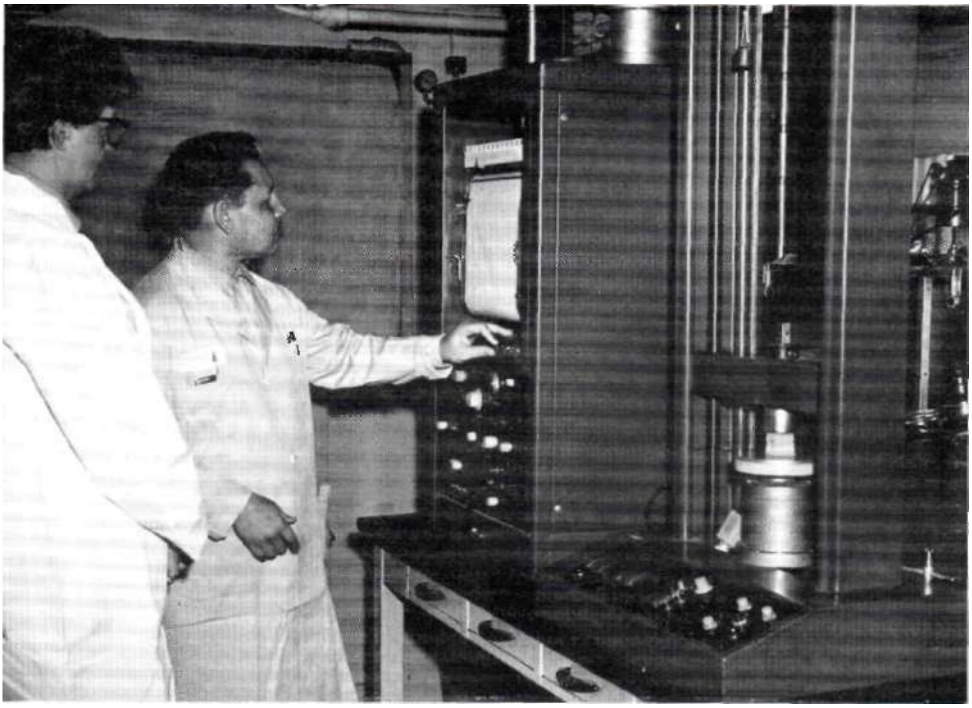

Fig. 1. Using a table model Instron Testing Machine to test a sample formulation. The forces can he read on the graph.

cent RTV 385. Density ranged from 7.6 lb. per cu. ft. for a sample containing 100 per cent RTV 386 to 68.3 lb. per cu. ft. for a sample containing 100 per cent RTV 385.

Table 1 presents compressive forces at both 15 per cent and 50 per cent deformation of the foam specimens. At 15 per cent deformation, the compressive force was found

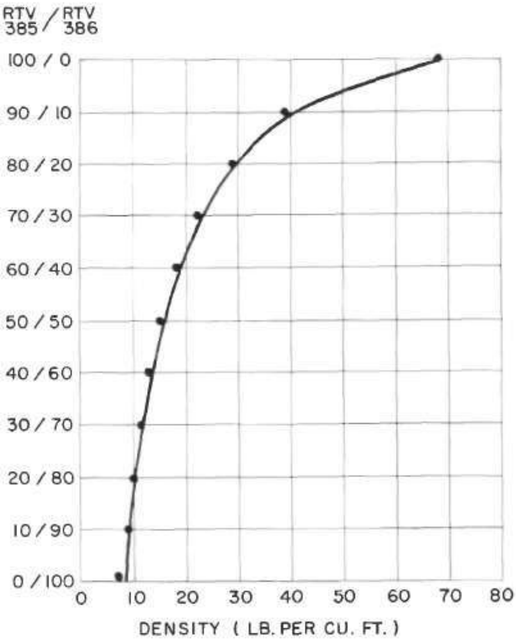

Fig. 2. Foam density. The density increases at a higher rate when the formulation contains more than 50 per cent RTV 385.

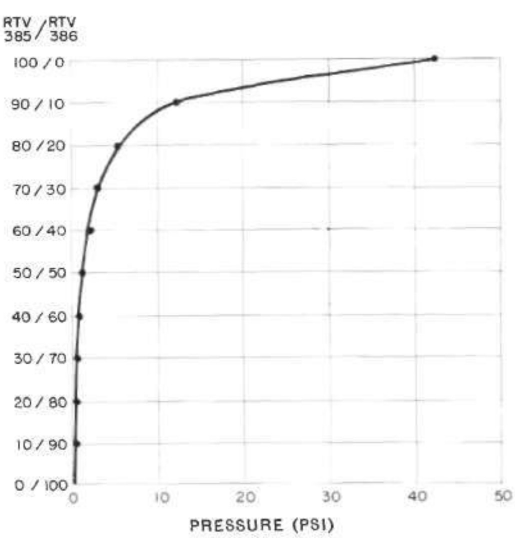

Fig. 3. Pressure at 15 per cent deformation. The more pronounced changes occur in samples containing more than 50 per cent RTV 385.

to be 0.4 psi on a specimen containing no RTV 385, while on a sample comprised 100 per cent of RTV 385 the compressive force increased a hundredfold to 42.86 psi. The

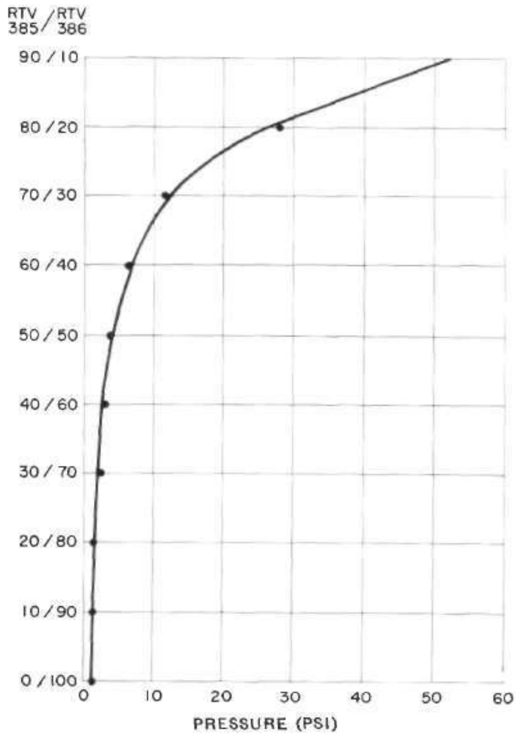

Fig. 4. Pressure at 50 per cent deformation. The test sample containing 100 parts RTV 385 exceeded the instrument load range.

graphical representations of these changes in Figure 3 and in Figure 4 show that samples containing more than 50 per cent RTV 385 exhibited more pronounced changes in compressive forces at both 15 per cent and 50 per cent deformations. In determining compressive force at 50 per cent deformation, it was found that a sample containing 90 parts RTV 385 and 10 parts RTV 386 gave results of 51 psi. The test sample containing 100 parts RTV 385 exceeded the instrument load range. However, if one assumes that the behavior of the material would follow a pattern similar to that at 15 per cent deformation, one could expect the compressive forces to exceed 128 psi; that is, 100 times the compressive forces on the test sample containing no RTV 385.

The tear resistance of this material (Fig. 5) was found to be very low. The maximum tear resistance was found to be 2 lb. per in. for a sample composed 100 per cent of RTV 385. A sample composed 100 per cent of RTV 386

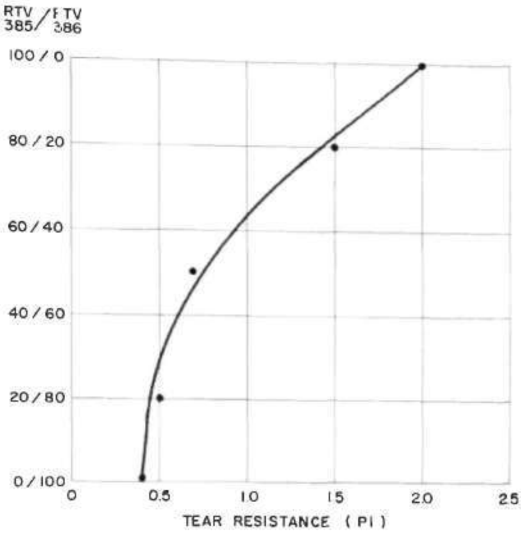

Fig. 5. Foam tear resistance. Tests for tear resistance were performed on Samples 1, 3, 6, 9, and 11.

showed a tear resistance of 0.4 lb. per in. Tear tests were performed on Samples 1, 3, 6, 9, and 11 only.

SUMMARY AND CONCLUSIONS

Observations were made of a number of the physical properties of silicone rubber prepared from RTV 385 and RTV 386 with an appropriate amount of catalyst. The properties specifically considered were density, compressive forces, and tear resistance. These properties were considered because they can be changed by varying the proportions of the components in the formulations.

The results obtained show comparable changes and their magnitudes. These results may be used to choose a formulation which will give predetermined density and compressive-force results. Analysis of the results shows that the more significant changes in the physical properties occur when an amount greater than 50 per cent of RTV 385 is used in the formulation. It follows that fairly precise consideration must be given to weighing out quantities of RTV 385 for higher compressive forces, particularly in the region of 80 to 100 parts of RTV 385. Slight changes in the proportions of the components in this region produce very large changes in compressive forces.

The tear resistance of this material was found to be very low. This was to be expected, because foam materials in general offer little resistance to tension or tear.