DEVELOPMENT WORK ON IMPROVED HIGH
MODULUS STRUCTURAL GLASS FIBER

23 August 1957

Prepared under Navy, Bureau of
Aeronautics
Contract NOas 55-213-c

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Tenth Progress Report
Covering Four Months to end of
Contract on June 30, 1957

1 March 1957 through 30 June 1957

IMPERIAL GLASS CORPORATION

BELLAIRE, OHIO

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WORK TO BE DONE

Under Contract No. 55 13-c from Department of Navy, Bureau of Aeronautics, Washington, D. C., Imperial Glass Corporation was authorized to develop an improved high modulus structural glass fiber and evaluate the use thereof for the reinforcement of plastic materials, to get objectives as follows:

(a) Young's modulus of elasticity of approximately 20,000,000 P.S.I.

(b) Physical properties of glass equal to or superior to commercially available glass fibers for plastic reinforcement.

(c) Specific gravity not to exceed 3.0.

WORK DONE

The first part of the period was spent in the final assembly of all equipment needed to form 50 fibers into a strand coated with a binder which would hold fibers together while being traversed and wound on a forming tube. The equipment was so arranged that a strand could be pulled at a speed of 6000 lineal feet per minute and still traversed to a sufficient degree that the strand could later be removed from the package without breaking the individual glass fibers. After the unit was completed in all its component parts, it was checked mechanically and then operated with a glass of known fiberizing characteristics. With this glass the equipment operated well, and with a heavy mineral oil as a binder, several packages were formed from which fiber could be removed a day or a week after manufacture of the fiber. This development work requires that the glass strand be coated with a chemical binder which would hook the polyester to the glass with a high degree of adhesion, and at the same time the binder must be just strong enough to hold the fifty fibers together in a strand and still furnish the lubrication on the surface of the fiber to allow it to be handled through the twisting or weaving stage. For these reasons it was decided to apply a heavy mineral oil binder to the fifty fiber strand as a binder and lubricant. After weaving, the mineral oil could be removed by heat treating the cloth and at this point NOL-24 finish could be applied to give a chemical bond between the polyester resin and the glass. The mineral oil gave an ignition loss of 2-1/4% to 5% after application and drying. This percent is within the range of commercial fibrous glass yarn production and thought to be satisfactory for this development work.

After the unit was operated twice with different melts of #561 (see table) in an attempt to fiberize this high modulus glass, it was discovered that the higher temperatures required to make this glass flow caused a very hot temperature band in the middle of the crucible, but the lower tip section froze and the glass crystallized at the tips. In order to remelt the glass at the tips, the center of the crucible had to be raised to a temperature of approximately 2800°F. Then when the glass melted at the tips, the glass that flowed from the hot section of the crucible to the tips was too fluid and it could not be fiberized. So, it was determined that the temperature gradiant on our melting furnace could be improved to handle these difficult experimental glasses. This improvement could be accomplished by changing the distribution of heat from the high present high frequency coil or through the purchase of a coil with different characteristics as to the amount of copper along the center of the crucible as compared with the distribution at both ends.

During the period work was continued with experimental glasses in the one orifice electric furnace to continue to refine the glass composition to give the best working "high modulus glass" that can be found for use in the 50 orifice equipment.

Table 1

GLASS COMPOSITIONS

Glass	SiO_2	Li_2O	CaO	MgO	BeO	TiO_2	ZrO_2	CeO_2	Co_2O_3	B_2O_3	Al_2O_3
N-655	49	6	15.7	10.8	10	4.5	2	—	2	—	—
N-656	41	5	15.4	10.6	10	2.0	7	—	3	6	—
N-657	41	5	15.4	10.6	10	7.0	2	—	3	6	—
N-658	44	5	15.4	10.6	10	2.0	7	—	3	3	—
N-659	55	5	5	15	8.5	4.5	3.5	—	3.5	—	—
N-660	50	5	5	20	8.5	4.5	3.5	—	3.5	—	—
N-661	50	5	15.1	11.4	10	4.5	2	—	2	—	—
N-662	50	5	14.5	12.0	10	4.5	2	—	2	—	—
N-663	50	5	13.9	12.6	10	4.5	2	—	2	—	—
N-664	50	5	13.32	13.18	10	4.5	2	—	2	—	—
N-665	50	5	12.73	13.77	10	4.5	2	—	2	—	—
N-666	50	5	12.15	14.35	10	4.5	2	—	2	—	—
N-667	50	5	11.55	14.95	10	4.5	2	—	2	—	—
N-668	50	4.5	15.7	10.8	10	3.0	3	—	3	—	—
N-669	50	4.0	15.7	10.8	10	3.0	3.5	—	3	—	—
N-670	50	3.5	15.7	10.8	10	3.0	4	—	3	—	—
N-671	52	3.0	15.7	10.8	8	3.0	4.5	—	3	—	—
N-672	53	3.0	16	11	8	4.0	5.0	—	—	—	—

TABLE II

GLASS PROPERTIES

GLASS N	DENSITY ρ	FLOW POINT °F	E x 10^6 p.s.i. BULK RAW	BULK ANNLD.	FIBER DYNAMIC	REMARKS D. = Devitrified
655	2.902	15[illegible]	17.9	18.85	16.56	D. making rods. D in bushing
656	2.950	-	18.7	19.3	-	D. could not pull fibers
657	2.950	-	18.8	19.6	-	D. could not pull fibers
658	2.950	-	[illegible]	19.3	-	D. could not pull fibers
659	2.830	1603	17.55	18.1	17.7	Works well. OK in bushing.
660	-	1616	18.1	18.3	-	D. badly. One rod. No fibers
661	2.891	1622	18.45	19.15	18.34	D. somewhat. Pulled fibers 2420°F.
662	2.892	1577	18.75	19.3	17.58	D. some. Pulled fibers 2400°F.
663	2.892	1583	18.45	18.9	18.3	D. some. Probed tips Fibers at 2320°F.
664	2.950	1612	18.5	19.1	17.65	D. No good in bushing
665	2.90	1626	18.7	19.2		D. No fibers
666	2.878	1594	18.7	19.45	18.00	D. Probe tips. Hard to work
667	2.90	-	18.7	19.05	18.38	D. No rods for flow point
668	2.933	1591	18.1	18.72	17.67	Pulls fibers good at 2320°F
669	2.95	1600	18.22	19.05	17.79	Pulls fibers good at 2380°F
670	2.59	-	18.6	19.18	17.34	Flow point rods D. Fibes at 2400°F
671	2.95	1656	17.3	17.98	17.37	Pulls good at 2160°F. No tip cooling
672	2.922	1722	17.3	17.81	16.56	Pulls good. Wide working range.

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