CHEMICAL ANALYSIS

	$Mg_6Si_4O_{11}(OH)_6H_2O$ Chrysotile			$NaFe_3^{II}Fe_2^{III}Si_8(OH)_2$ Crocidolite			$(Fe,Mg)\ SiO_3$		$(Mg,Fe)_7Si_8O_{22}(OH)$
	Canada %	Africa %	Arizona %	Cape %	Transvaal %	Australia %	Amosite Africa %	Montasite Africa %	Anthophyllite U.S. %
SiO_2	38.90	38.40	41.07	46.70	57.83	51.50	48.46	55.90	57.16
MgO	41.45	41.80	42.35	2.74	2.53	5.16	6.24	4.55	30.07
Fe_2O_3	2.57	3.18	0.42	24.99	7.20	18.53	4.33	2.10	2.66
FeO	1.73	0.83	0.14	14.00	24.44	14.52	34.90	32.40	4.60
Al_2O_3	0.77	1.13	0.55	0.59	-----	1.05	0.61	0.45	2.00
CaO	<0.10	0.32	1.02	2.38	1.12	0.14	0.80	0.50	0.20
K_2O	0.18	0.08	0.03	0.20	-----	0.19	0.44	0.35	0.02
Na_2O	0.09	0.06	Tr	3.72	3.98	5.66	0.01	Tr	Tr
Mn_2O_3	0.03	0.02	0.07	0.18	-----	0.01	0.77	-----	0.16
H_2O (105°C)	1.27	1.08	2.15	0.75	-----	0.49	0.85	0.75	0.20
H_2O Ignition Loss (1800°F)	13.95	14.35	13.97	3.06*	1.67*	1.54*	0.0*	2.65*	3.35
NiO	0.21	0.15	Tr	Tr	-----	-----	Tr	-----	0.15
P_2O_5	<0.05	<0.10	0.01	0.13	-----	<0.10	0.08	-----	0.02
TiO2	<0.01	<0.01	0.01	0.04	-----	<0.01	0.08	-----	0.05
Sulphates as SO_3	0.09	0.17	0.20	0.03	-----	-----	0.02	-----	Tr
Chlorides as Cl	0.27	0.02	0.08	<0.01	-----	0.02	0.02	-----	Tr
Cr_2O_3	0.03	-----	0.03	-----	-----	-----	-----	-----	0.28
Surface Area by Nitrogen M 2/g	19-21	-----	-----	9-10	-----	-----	8-9	-----	6-7
pH	9.7	-----	-----	9.4	-----	-----	8.8	-----	10.0

* Low value due to oxidation of Fe++ to Fe +++.

Actinolite = $Ca(MgFe)_3\ (SiO_3)_4$. Tremolite = $Ca_2Mg_5Si_8O_{22}(OH)_2$.

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PROPERTIES OF ASBESTOS FIBRES

	ACTINOLITE	AMOSITE (FERRO ANTHOPHYLLITE)	ANTHOPHYLLITE	CHRYSOTILE	CROCIDOLITE	TREMOLI
STRUCTURE	RETICULATED LONG PRISMATIC CRYSTALS AND FIBRES	LAMELLAR, COARSE TO FINE FIBROUS AND ASBESTIFORM	LAMELLAR, FIBROUS ASBESTIFORM	IN VEINS OF SERPENTINE, ETC.	FIBROUS IN IRON-STONES	LONG, PRISMAT FIBROUS AGGRE
MINERAL ASSOCIATION	IN LIMESTONE AND IN CRYSTALLINE SCHISTS	IN CRYSTALLINE SCHISTS, ETC.	IN CRYSTALLINE SCHISTS AND GNEISSES	IN ALTERED PERIDOTITE ADJACENT TO SERPENTINE & LIMESTONE NEAR CONTACT WITH BASIC IGNEOUS ROCKS	IRON RICH SILICIOUS ARGILLITE IN QUARTZOSE SCHISTS	IN Mg LIMESTON ATION PROD. OF NESIAN ROCKS. AND IGNEOUS RO
ORIGIN	RESULTS OF CONTACT METAMORPHISM	METAMORPHIC	METAMORPHIC, USUALLY FROM OLIVINE	ALTERATION & METAMORPHISM OF BASIC IGNEOUS ROCKS RICH IN MAGNESIAN SILICATES	REGIONAL METAMORPHISM	METAMORP
VEINING	SLIP OR MASS FIBRE	CROSS FIBRE	SLIP, MASS FIBRE UNORIENTED AND INTERLACING	CROSS AND SLIP FIBRES	CROSS FIBRE	SLIP OR MASS
ESSENTIAL COMPOSITION	Ca, Mg, Fe, SILICATE WATER UP TO 5%	SILICATE OF Fe AND Mg HIGHER IRON THAN ANTHOPHYLLITE	Mg SILICATE WITH IRON	HYDROUS SILICATES OF MAGNESIA	SILICATE OF Na AND Fe WITH SOME WATER	Ca & Mg SILICA SOME WATER
THEORETICAL FORMULA	$Ca(Mg.Fe)_3(SiO_3)_4 \times H_2O$	$(Fe.Mg)SiO_3$ 1-5% H_2O	$(Mg.Fe)_7Si_8O_{22}(OH)_2$	$3MgO.\ 2SiO_2 2H_2O$	$Na\ Fe\ (SiO_3)_2 FeSiO_3 \times H_2O$	$Ca_2Mg_5Si_8O_2$
CRYSTAL STRUCTURE	LONG & THIN COLUMNAR TO FIBROUS	PRISMATIC, LAMELLAR TO FIBROUS	PRISMATIC, LAMELLAR TO FIBROUS	FIBROUS AND ASBESTIFORM	FIBROUS	LONG & THIN C TO FIBROUS
CRYSTAL SYSTEM	MONOCLINIC	~~ORTHORHOMBIC~~ Monoclinic	ORTHORHOMBIC	MONOCLINIC (PSEUDO-ORTHORHOMBIC?)	MONOCLINIC	MONOCLINI
COLOR	GREENISH	ASH GRAY, GREENISH, OR BROWN	GRAYISH WHITE, BROWN-GRAY OR GREEN	WHITE, GRAY, GREEN, YELLOWISH	LAVENDER, BLUE, GREENISH	GRAY-WHITE, G YELLOWISH, B
LUSTRE	SILKY	VITREOUS, SOMEWHAT PEARLY	VITREOUS TO PEARLY	SILKY	SILKY TO DULL	SILKY
HARDNESS	6±	5.5—6.0	5.5—6.0	2.5—4.0	4	5.5
SPECIFIC GRAVITY	3.0—3.2	3.1—3.25	2.85—3.1	2.4—2.6	3.2—3.3	2.9—3.2
CLEAVAGE	110 PERFECT	110 PERFECT	110 PERFECT	010 PERFECT	110 PERFECT	110 PERFEC
OPTICAL PROPERTIES	BIAXIAL NEGATIVE EXTINCTION INCLINED	BIAXIAL & POSITIVE EXTINCTION PARALLEL	BIAXIAL POSITIVE EXTINCTION PARALLEL	BIAXIAL POSITIVE EXTINCTION PARALLEL	BIAXIAL ± EXTINCTION INCLINED	BIAXIAL NEGAT EXTINCTION IN
REFRACTIVE INDEX	1.63± WEAKLY PLEOCHROIC	1.64±	1.61±	1.50 — 1.55	1.7 PLEOCHROIC	1.61±
FUSIBILITY	FUSIBLE AT 4	FUSIBLE AT 6, LOSES WATER AT MODERATE TEMPERATURES	INFUSIBLE OR DIFFICULTLY FUSIBLE	FUSIBLE AT 6	FUSIBLE AT 3	FUSIBLE AT
FLEXIBILITY	BRITTLE AND NONFLEXIBLE	GOOD, LESS THAN CRYSOTILE	VERY BRITTLE, NONFLEXIBLE	VERY FLEXIBLE	FAIR TO GOOD	GENERALLY BR SOMETIMES FLE
LENGTH	SHORT TO LONG	2" TO 11" VARIES	SHORT	SHORT TO LONG	SHORT TO LONG	SHORT TO LO
TEXTURE	HARSH	COARSE BUT SOMEWHAT PLIABLE	HARSH	SOFT TO HARSH. ALSO SILKY	SOFT TO HARSH	GENERALLY HAR SOMETIMES SOF
TENSILE STRENGTH	VERY WEAK	FAIR, LESS THAN CHRYSOTILE	VERY WEAK	VERY GOOD	VERY GOOD. HIGHEST OF ALL VARIETIES	WEAK
ACID RESISTANCE	RELATIVELY INSOLUBLE IN HCl	FAIRLY RESISTANT TO ACIDS	FAIRLY RESISTANT TO ACIDS	SOLUBLE UP TO APPROXIMATELY 57%	FAIRLY RESISTANT TO ACIDS	FAIRLY RESIST ACIDS
SPINNABILITY	POOR	FAIR	POOR	BEST	FAIR	GENERALLY POO ARE SPINNABLE

PROPERTIES OF ASBESTOS FIBRES

CTINOLITE	AMOSITE (FERRO ANTHOPHYLLITE)	ANTHOPHYLLITE	CHRYSOTILE	CROCIDOLITE	TREMOLITE
ATED LONG PRIS- RYSTALS AND	LAMELLAR, COARSE TO FINE FIBROUS AND ASBESTIFORM	LAMELLAR, FIBROUS ASBESTIFORM	IN VEINS OF SERPENTINE, ETC.	FIBROUS IN IRON-STONES	LONG, PRISMATIC AND FIBROUS AGGREGATES
ESTONE AND IN LLINE SCHISTS	IN CRYSTALLINE SCHISTS, ETC.	IN CRYSTALLINE SCHISTS AND GNEISSES	IN ALTERED PERIDOTITE ADJACENT TO SERPENTINE & LIMESTONE NEAR CONTACT WITH BASIC IGNEOUS ROCKS	IRON RICH SILICIOUS ARGILLITE IN QUARTZOSE SCHISTS	IN Mg LIMESTONES AS ALTERATION PROD. OF HIGHLY MAGNESIAN ROCKS, METAMORPHIC AND IGNEOUS ROCKS,
LTS OF CONTACT MORPHISM	METAMORPHIC	METAMORPHIC, USUALLY FROM OLIVINE	ALTERATION & METAMORPHISM OF BASIC IGNEOUS ROCKS RICH IN MAGNESIAN SILICATES	REGIONAL METAMORPHISM	METAMORPHIC
R MASS FIBRE	CROSS FIBRE	SLIP, MASS FIBRE UNORIENTED AND INTERLACING	CROSS AND SLIP FIBRES	CROSS FIBRE	SLIP OR MASS FIBRE
Fe, SILICATE P TO 5%	SILICATE OF Fe AND Mg HIGHER IRON THAN ANTHOPHYLLITE	Mg SILICATE WITH IRON	HYDROUS SILICATES OF MAGNESIA	SILICATE OF Na AND Fe WITH SOME WATER	Ca & Mg SILICATE WITH SOME WATER
$e)_3(SiO_3)_4 \times H_2O$	$(Fe.Mg)SiO_3$ 1-5% H_2O	$(Mg.Fe)_7Si_8O_{22}(OH)_2$	$3MgO.\ 2SiO_2 2H_2O$	$Na\ Fe\ (SiO_3)_2 FeSiO_3 \times H_2O$	$Ca_2Mg_5Si_8O_{22}(OH)_2$
THIN COLUMNAR OUS	PRISMATIC, LAMELLAR TO FIBROUS	PRISMATIC, LAMELLAR TO FIBROUS	FIBROUS AND ASBESTIFORM	FIBROUS	LONG & THIN COLUMNAR TO FIBROUS
ONOCLINIC	~~ORTHORHOMBIC~~ Monoclinic	ORTHORHOMBIC	MONOCLINIC (PSEUDO-ORTHORHOMBIC?)	MONOCLINIC	MONOCLINIC
GREENISH	ASH GRAY, GREENISH, OR BROWN	GRAYISH WHITE, BROWN-GRAY OR GREEN	WHITE, GRAY, GREEN, YELLOWISH	LAVENDER, BLUE, GREENISH	GRAY-WHITE, GREENISH, YELLOWISH, BLUISH
SILKY	VITREOUS, SOMEWHAT PEARLY	VITREOUS TO PEARLY	SILKY	SILKY TO DULL	SILKY
6±	5.5—6.0	5.5—6.0	2.5—4.0	4	5.5
3.0—3.2	3.1—3.25	2.85—3.1	2.4—2.6	3.2—3.3	2.9—3.2
0 PERFECT	110 PERFECT	110 PERFECT	010 PERFECT	110 PERFECT	110 PERFECT
L NEGATIVE TION INCLINED	BIAXIAL & POSITIVE EXTINCTION PARALLEL	BIAXIAL POSITIVE EXTINCTION PARALLEL	BIAXIAL POSITIVE EXTINCTION PARALLEL	BIAXIAL ± EXTINCTION INCLINED	BIAXIAL NEGATIVE EXTINCTION INCLINED
EAKLY PLEOCHROIC	1.64±	1.61±	1.50 — 1.55	1.7 PLEOCHROIC	1.61±
IBLE AT 4	FUSIBLE AT 6, LOSES WATER AT MODERATE TEMPERATURES	INFUSIBLE OR DIFFICULTLY FUSIBLE	FUSIBLE AT 6	FUSIBLE AT 3	FUSIBLE AT 4
AND NONFLEXIBLE	GOOD, LESS THAN CRYSOTILE	VERY BRITTLE, NONFLEXIBLE	VERY FLEXIBLE	FAIR TO GOOD	GENERALLY BRITTLE, SOMETIMES FLEXIBLE
RT TO LONG	2" TO 11" VARIES	SHORT	SHORT TO LONG	SHORT TO LONG	SHORT TO LONG
HARSH	COARSE BUT SOMEWHAT PLIABLE	HARSH	SOFT TO HARSH, ALSO SILKY	SOFT TO HARSH	GENERALLY HARSH, SOMETIMES SOFT
ERY WEAK	FAIR, LESS THAN CHRYSOTILE	VERY WEAK	VERY GOOD	VERY GOOD, HIGHEST OF ALL VARIETIES	WEAK
VELY INSOLUBLE	FAIRLY RESISTANT TO ACIDS	FAIRLY RESISTANT TO ACIDS	SOLUBLE UP TO APPROXIMATELY 57%	FAIRLY RESISTANT TO ACIDS	FAIRLY RESISTANT TO ACIDS
POOR	FAIR	POOR	BEST	FAIR	GENERALLY POOR, SOME ARE SPINNABLE

PHYSICAL PROPERTIES OF ASBESTOS

	CHRYSOTILE	AMOSITE	ANTHOPHYLLITE	CROCIDOLITE	TREMOLITE	ACTINOLITE
Specific Heat Btu/lb/°F	0.266	0.193	0.210	0.201	0.212	0.217
Tensile Strength lbs/sq in.	80,000 100,000	16,000 90,000	4,000 & less	100,000 300,000	1,000 8,000	1,000 & less
Temp. at Max. Ignition Loss °F	1800	1600 to 1800	1800	1200	1800	——
Filtration Properties	Slow	Fast	Medium	Fast	Medium	Medium
Electric Charge	+	-	-	-	-	-
Fusion Point °F	2770	2550	2675	2180	2400	2540
Spinnability	Very good	Fair	Poor	Fair	Poor	Poor
Resistance to Acids and Alkalies	Poor	Good	Very good	Good	Good	Fair
Magnetite Content	0-5.2	0	0	3.0-5.9	0	——
Mineral Impurities Present	Iron, Chrome, Nickel, Lime	Iron	Iron	Iron	Lime	Lime, Iron
Flexibility	High	Good	Poor	Good	Poor	Poor
Resistance to Heat	Good. Brittle at high temp.	Good. Brittle at high temp.	Very good	Poor, Fuses	Fair to good	——
Ionizable Salts Micro-Mhos (Relative Elec. Conductance)	1.82	1.34	0.58	0.84	——	——
Color	Green, Gray to White	Yellowish Brown	Yellowish Brown. Sometimes almost white.	Blue	White	Greenish

COMBUSTION ANALYSIS OF CHRYSOTILE ASBESTOS

Source of Fiber	Temperature °F	Per Cent H_2O	Per Cent CO_2	Total Per Cent of H_2O + CO_2	Per Cent Ignition Loss of Fiber	Carbon Dioxide Calculated in Terms of Percentage of $MgCO_3$	$CaCO_3$
Arizona	1000	3.37	0.54	3.91	3.87	1.03	
"	1800	12.89	1.91	14.80	14.80	1.03	3.11
Australian	1000	1.50	0.66	2.16	2.06	1.26	
"	1800	12.48	0.96	13.44	13.33	1.26	0.68
Canadian (A)	1000	5.47	0.85	6.32	6.23	1.62	
"	1800	14.28	0.97	15.25	15.17	1.62	0.27
Rhodesian	1000	1.82	2.54	4.36	4.28	4.85	
"	1800	12.00	2.89	14.89	14.84	4.85	0.79
Canadian (B)	1000	3.75	0.45	4.20	4.14	0.86	
"	1800	13.31	0.48	13.79	13.75	0.86	0.07
Russian	1000	1.98	0.77	2.75	2.64	1.47	
"	1800	11.74	1.06	12.80	12.72	1.47	0.66
Canadian (C)	1000	2.25	0.47	2.72	2.66	0.90	
"	1800	11.93	0.51	12.44	12.40	0.90	0.09

EFFECT OF TEMPERATURE ON LOSS IN WEIGHT OF ASBESTOS FIBRES

		Loss in Weight				
TEMP. °F	TIME	AMOSITE %	ANTHOPHYLLITE %	CHRYSOTILE %	CROCIDOLITE %	TREMOLITE %
400	2 hrs	0.23	0.05	0.30	0.08	0.04
600	"	0.57	0.24	0.85	0.25	0.08
700	"	0.80	0.30	1.78	0.49	0.13
800	"	0.98	0.38	2.17	0.73	0.22
900	"	1.07	0.41	2.83	0.83	0.26
1000	"	1.16	0.44	3.99	0.86	0.29
1100	"	1.36	0.52	10.38	1.00	0.37
1200	"	1.39	0.54	12.75	1.04	0.37
1400	"	1.43	0.54	13.43	1.03	0.47
1500	"	-	0.64	-	-	0.56
1600	"	1.52	1.12	13.62	0.93*	0.67
1700	"	-	1.73	-	-	1.40
1800	"	1.53	2.39	13.77	0.77*	2.18

* Iron changing in weight due to oxidation.

TABLE II

Solubility of Asbestos

Per Cent Loss in Weight Refluxing Two Hours
25% Acid or Caustic

	HCl	CH_3COOH	H_3PO_4	H_2SO_4	NaOH
Actinolite	20.31	12.28	20.19	20.38	9.25
Amosite	12.84	2.63	11.67	11.35	6.97
Anthophyllite	2.66	0.60	3.16	2.73	1.22
Chrysotile	55.69	23.42	55.18	55.75	0.99
Crocidolite	4.38	0.91	4.37	3.69	1.35
Tremolite	4.77	1.99	4.99	4.58	1.80

Per Cent Loss in Weight - Room Temperature 26°C for 528 Hours
25% Acid or Caustic

	HCl	CH_3COOH	H_3PO_4	H_2SO_4	NaOH
Actinolite	22.55	12.14	20.10	20.60	9.43
Amosite	12.00	3.08	11.83	11.71	6.82
Anthophyllite	2.13	1.04	3.29	2.90	1.77
Chrysotile	56.00	24.04	56.45	56.00	1.03
Crocidolite	3.14	1.02	3.91	3.48	1.20
Tremolite	4.22	1.41	4.89	4.74	1.65

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EFFECT OF HEAT UPON TENSILE STRENGTH OF CANADIAN CHRYSOTILE CRUDE

	TENSILE STRENGTH lb/sq in.	PER CENT OF ORIGINAL TENSILE STRENGTH
Original Crude - No Heat	131,000	-
Heated @ 3 Min. @ 600°F	120,000	91.6
" " " " @ 800°F	96,000	73.3
" " " " @ 1000°F	78,000	59.5
" " " " @ 1200°F	42,000	32.0

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COMPARISON OF TENSILE STRENGTHS OF VARIOUS MATERIALS

TYPE OF MATERIAL	TENSILE STRENGTH IN LB./SQ. IN.
INGOT IRON	45,000
WROUGHT IRON	48,000
CARBON STEEL	155,000
NI-CR STEEL	243,000
PIANO STEEL WIRE	300,000
COTTON FIBER	73,000 TO 89,000
ROCK WOOL	60,000
GLASS FIBER	100,000 TO 200,000
CHRYSOTILE ASBESTOS	80,000 TO 100,000
CROCIDOLITE ASBESTOS	100,000 TO 300,000
AMOSITE ASBESTOS	16,000 TO 90,000
TREMOLITE ASBESTOS	1,000 TO 8,000

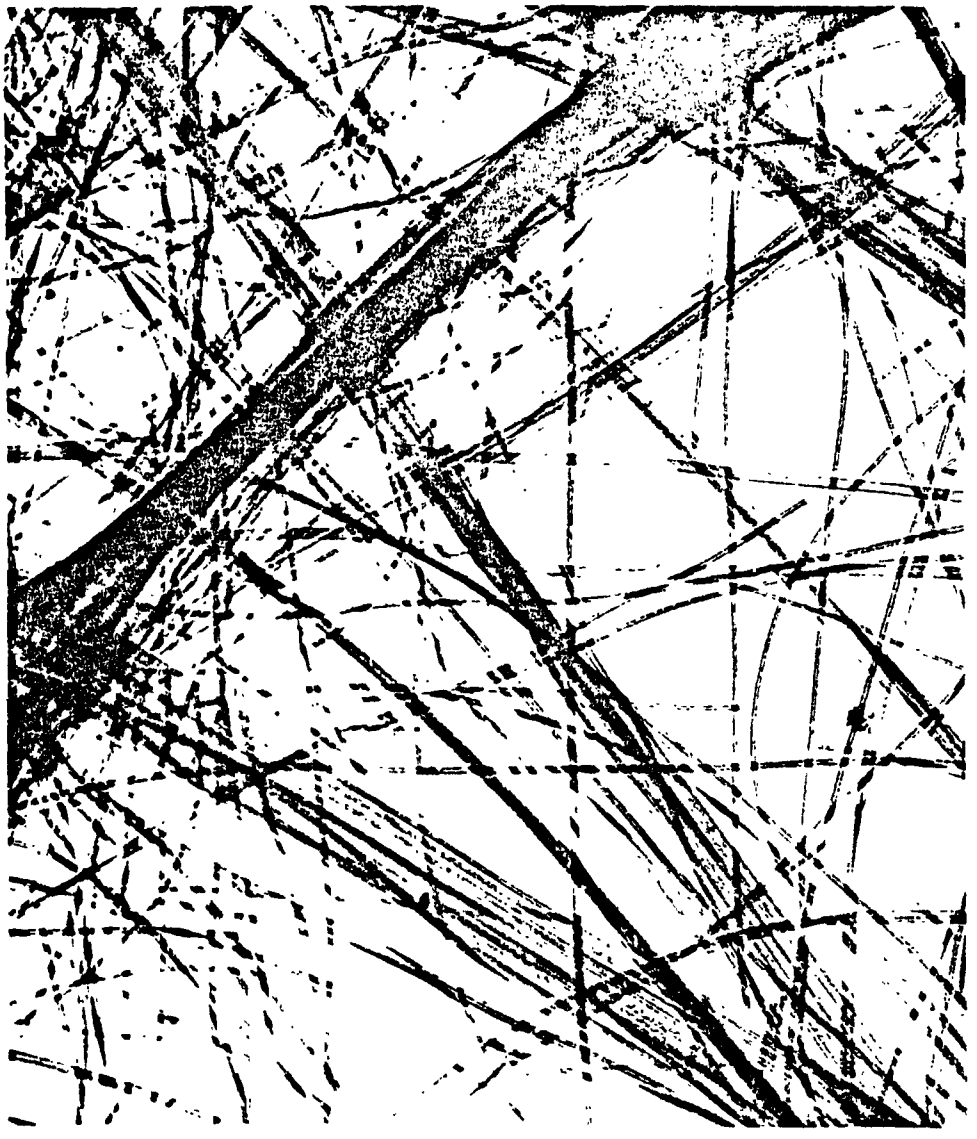
COMPARISON OF THE SURFACE AREA OF VARIOUS FIBERS

TYPE OF FIBER	SURFACE AREA BY N_2 ADSORPTION SQ. CM / GRAM
NYLON	3100
ACETATE RAYON	3800
COTTON	7200
SILK	7600
WOOL	9600
VISCOSE RAYON	9800
ASBESTOS (CHRYSOTILE)	130,000 TO 220,000

COMPARISON OF APPROXIMATE FIBER DIAMETERS

TYPE OF FIBRE	FIBER DIAMETER IN INCHES	FIBRILS IN ONE (1) LINEAR INCH
HUMAN HAIR	.00158	630
RAMIE	.000985	1015
WOOL	0008 TO 0011	910 TO 1250
COTTON	.0004	2500
RAYONS	.0003	3300
NYLON	.00 03	3300
GLASS	.00026	3840
ROCK WOOL	.000142 TO 000284	3520 TO 7040
ASBESTOS(CHRYSOTILE)	.000000706 TO .00000118	850,000 TO 1,400,000

ELECTRON MICROGRAPH OF CHRYSOTILE ASBESTOS



X 31,000

PHOTOMICROGRAPHS OF

CHRYSOTILE ASBESTOS



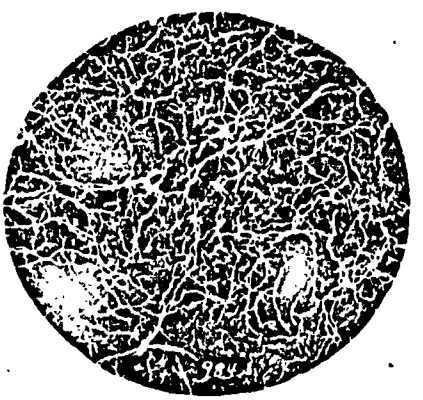
HARSH TYPE

100 X



SEMI-HARSH TYPE

100 X



SOFT TYPE

100 X