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VANDERBILT Report

Filler Minerals Reference

A Guide to Filler Properties and Uses

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No. 703

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A Guide to Filler Properties and Uses

	Particle Shape	GE Brightness	Oil Absorption	Median P. S., μm	Hegman Fineness	pH 10%	Specific Gravity	Refractive Index	Mohs Hardness	lbs/ solid gal
Alumina Trihydrate	irregular	93-100	32-44	0.25-26	0-7+	7-9.5	2.42	1.57	2.5-3.5	20.2
Barite	irregular	80-95	10-14	1-11	3-6	7-9	4.40	1.64	3-3.5	36.6
Calcium Carbonate										
Ground	irregular	91-95	8-18	1-40	0-7+	9-10	2.71	1.66	3	22.5
Precipitated	irregular	95-98	30-50	0.07-0.7	7+	9-10	2.70	1.66	3	22.5
Chlorite	platy	78-87	25-45	2-9	2.5-6	8-9	2.80	1.57	2-2.5	23.2
Diatomite	irregular	85-90	100-200	4-20	0-4	9-10	2.30	1.46	5.5-6	19.2
Feldspar	irregular	89-94	19-28	3-16	0-6.5	8-9	2.62	1.53	6-6.5	21.6
Kaolin Clay										
Airfloat	platy	65-75	30-40	0.3-1.8	4-6	4-5.5	2.58	1.56	2	21.9
Water-washed	platy	80-92	30-45	0.2-4.8	5-6	3.5-8	2.58	1.56	2	21.9
Delaminated	platy	86-92	40-45	0.4-1.0	6-7	6-8	2.58	1.56	2	21.9
Calcined	platy	84-97	50-95	0.8-2.9	4-5.5	5-6	2.50-2.60	1.62	3-4	21.2-22.3
Mica	platy	65-80	40-70	2-40	0-5	7-9	2.82	1.60	2-2.5	23.3
Nepheline Syenite	irregular	88-91	21-30	2-16	0-6.5	10	2.61	1.53	5.5-6	21.7
Pyrophyllite	Mixed: platy, irregular	75-80	24-26	10-14	0-1	6-7	2.80	1.59	4-5	23.4
Silica										
Ground	irregular	80-92	18-42	1.7-21	0-7+	6-8	2.65	1.54	7	22.1
Novaculite	platy	80	17-20	3-15	0-7.5	6-8	2.65	1.55	7	22.1
Precipitated	irregular	90-94	150-250	2-12	7+	6.5-7.5	2.10	1.46	1	17.5
Fumed	irregular	90-94	250-350	-	7+	3.6-4.3	2.20	1.46	1	18.3
Talc	platy	80-90	25-55	1-15	3-6.5	9.5	2.75	1.6	1-1.5	22.6
Wollastonite										
High aspect ratio	acicular	85-93	35-45	2-40	0-5	10	2.90	1.63	5-5.5	24.2
Low aspect ratio	Mixed: acicular, irregular	85-93	20-30	2-16	0-6.5	10	2.90	1.63	5-5.5	24.2

Alumina Trihydrate

Aluminum trihydrate (ATH) is used principally as a flame-retardant and smoke suppressant in plastics, rubber and carpet backings; it also improves arc-track resistance in plastics for electrical applications. As a filler in fine printing papers it increases opacity and brightness, and in paper coatings it imparts brightness, gloss and high ink receptivity. ATH is used as a reinforcing pigment in adhesives, where it improves cold flow properties and cohesion, and stabilizes pH. It is also used for TiO_2 extension and gloss control in interior and exterior coatings, powder coatings and low/no VOC systems, and as a nonreactive extender for UV curable coatings.

Barite

Paints and primers represent the largest use for filler-grade barite (barium sulfate). High brightness micronized barite is used as an extender to provide the weight that customers equate with quality, and because of its low binder demand for high loadings. Blanc fixe (precipitated barium sulfate) is used where a finer particle size is needed for denser packing of the paint film, as in premium metal primers, and to provide resistance to corrosion by acids and alkalis. Because their refractive index is close to that of binders, barite and blanc fixe have poor hiding and tinting strength. They function instead as extenders and spacers.

In rubber, fine-ground barite has little effect on cure, hardness, stiffness, or aging. Blanc fixe is used to provide similar compound softness and resilience, but better tensile strength and tear resistance. Barite is used to form dense coatings in PVC and polyurethane foam backings for carpeting and sheet flooring, and fine-ground barite is used as an inert filler in brake linings and clutch plates.

Micronized barite and blanc fixe are used, primarily to add weight, in bristolboard, playing cards, and heavy printing papers. Blanc fixe is used in the base coat of photographic papers as an inert substrate for the silver halide emulsion.

Calcium Carbonate

Dry-ground calcium carbonates are among the least expensive white fillers available. Wet-ground products are produced in finer particle size ranges. Wet-ground fine and ultrafine products are also sold in 75% solids slurry form for high-volume paint and paper applications. Precipitated calcium carbonate (PCC) is produced for applications requiring higher brightness, better TiO_2 extension, smaller particle size, greater surface area, lower abrasivity or higher purity.

Calcium carbonate is the most widely used white filler in paints because of its low cost, high brightness for TiO_2 extension, high purity, low abrasivity, and resistance to weathering. PCC and ultrafine wet-ground grades contribute to rheology and stability and provide good dry hide and gloss retention.

Calcium carbonate is also the most widely used filler in adhesives and sealants. The coarsest grades are used at high loadings in drywall joint cements and in ready-mix adhesives for heavy wall tile. Fine-ground grades are used as general-purpose fillers in most types of adhesives, sealants, and gap fillers because they allow economically high loadings without adversely affecting flow. High performance polymer-based adhesives and sealants use stearate-coated PCC and ultrafine natural products to control flow and slump on application, and to provide low modulus with good tear and tensile properties in the cured state.

Ground calcium carbonate is the most common filler in plastics due to its low cost, low abrasion, low oil absorption, low moisture, high brightness, and easy dispersion. These attributes account for its widespread use in rubber as well, where it can be used at very high loadings with little loss of compound softness, elongation, or resilience. PCC is used in plastics to improve mar and impact resistance, surface gloss, weatherability, shrinkage control, low and high temperature properties and dielectric properties, and to reduce plasticizer migration and crazing of molded parts. In rubber, stearate-coated ultrafine PCC is used for its low moisture absorption, good dispersion and good elastomer-filler contact, imparting good tensile strength, tear resistance, resilience, abrasion resistance and flex crack resistance.

Calcium carbonate, particularly PCC, is the predominant paper filler and coating in alkaline papermaking, where it provides opacity, high brightness, and good ink receptivity.

Diatomite

Diatomite used as a white filler is flux-calcined and then milled, screened, and air classified. In paint, its primary application, it is used to roughen the paint film to provide flatting and improved intercoat adhesion. It also improves film toughness and durability, and helps control vapor permeability for reduced blistering and peeling. Diatomite is used in mortars, grouts, plasters and stucco for improved plastic and cured properties.

Natural and flux-calcined products are used in certain specialty papers as a lightweight bulking agent, as a drainage aid, as an opacity builder, and as a fiber dispersion aid. In polyolefin films fine-ground products are used as antiblocking agents by projecting through the film surface and providing mechanical separation of film layers. Diatomites are used as processing aids (absorbents) in high-oil, highly loaded rubber compounds and as both processing aids and semi-reinforcing fillers in mechanical goods.

Feldspar

In plastics, rubber, adhesives, and coatings, feldspar offers low vehicle demand, high dry brightness with low tint strength, and resistance to abrasion and chemical degradation. In coatings it also provides good film durability and high resistance to chalking and frosting.

Kaolin Clay

The principal use of kaolin in coatings is as a TiO_2 extender. Partially calcined grades generally provide the best extension, durability, and dry hide. Water-washed and delaminated clays are used in water-based coatings to control gloss, film integrity, durability, scrub resistance, covering power, suspension ability, flow, and leveling.

The largest single use of kaolin in plastics is as calcined kaolin in PVC wire insulation to improve electrical resistivity. Calcined kaolin is also used in agricultural polyethylene films to improve IR absorption characteristics, and in engineering resins, both untreated and silane-treated, for improved physical properties and heat deflection. Airfloat and water-washed kaolins are used in thermosets to provide a smooth surface finish, reduced cracking, warping and crazing, and to obscure fiber reinforcement patterns. Delaminated clays improve thermoplastic physical properties, including enhanced impact resistance when surface-treated.

Kaolin for rubber is principally airfloat hard clay. Water-washed and delaminated clays are used for better color, physical properties, and abrasion resistance. Calcined and surface-treated clays are used for improved electrical properties and ease of extrusion.

High brightness, low abrasion water-washed kaolins are used as paper fillers. Kaolin is the preferred filler in acid pH papers. Partially calcined and delaminated grades act as TiO_2 extenders. Kaolins add brightness, gloss, smoothness, and ink receptivity to paper coatings. Fine particle size airfloat kaolins are used as pitch control agents.

In adhesives and sealants, kaolin is used to control flow, penetration, and adhesion on application, as well as adhesive strength, tear strength, tensile strength and elongation after cure.

Mica

Fine-ground and micronized mica is used in paint to improve suspension stability, to control film checking, chalking, shrinkage and blistering, to improve resistance to weathering, chemicals and water penetration, and to improve adhesion to most surfaces.

Mica is considered the most effective mineral for reducing warpage and increasing stiffness and heat deflection temperature in plastics. Fine-ground and micronized grades are also used to improve electrical, thermal and insulating properties. Its largest single use is in polyolefins.

Mica is used as an asbestos substitute in brake linings and gaskets, and as a mold lubricant and release agent in the manufacture of tires and other molded rubber goods.

Nepheline Syenite

Nepheline syenite is a natural blend of about 25% nepheline and 75% feldspar. It offers low vehicle demand, high brightness with low tint strength, abrasion resistance and good film durability. It is more widely used than feldspar in coatings, due in part to the absence of crystalline silica. Nepheline syenite is also used as a filler in plastics, rubber and adhesives because of its low vehicle demand, high dry brightness with low tint strength, and resistance to abrasion and chemical degradation.

Pyrophyllite

Coatings use fine-ground pyrophyllite products for low cost pigment extension. The product's platy components (pyrophyllite, kaolin, mica) promote good dispersion by inhibiting pigment settling, help film dry, and increase resistance to film cracking. Its high quartz content contributes to scrub resistance. Relatively coarse grades are used to impart mud-crack resistance to texture paints and block fillers, and checking/cracking/frosting resistance to exterior latex paints. Fine-ground pyrophyllite is also used in wallboard joint cements and in mastics to control rheology and provide reinforcement, and as a low cost alternative to kaolin and talc in rubber, plastics, adhesives and sealants applications that can accommodate its higher abrasivity.

Silica

As paint extender pigments, ground quartz and novaculite offer low binder demand for high loadings. The platy novaculite imparts additional mar, wear, and weather resistance. Precipitated silicas are used to provide flatting, mar resistance, and abrasion resistance. In certain specialty coatings they are also used for rheology control and as suspension aids.

Fine precipitated silica is the only fully reinforcing alternative to carbon black for general rubber compounding. It is used in compounds designed to be translucent or colored, and in general compounding, to promote abrasion resistance, cut growth resistance, tear strength, elastomer-to-textile adhesion, and resistance to heat aging. It is often used with silane coupling agents to improve matrix compatibility. Fumed silica is the common reinforcing filler in silicone elastomers.

Synthetic silicas are used as thixotropes in unsaturated polyester resins and gel coats, in PVC plastisols, and in epoxy resins. They also function as antiblocking and antislip agents by absorbing plasticizers that can cause tack and by providing an imperceptible surface roughness. They are used as matting or flatting agents and as plate-out agents in highly plasticized compounds. Fine-ground natural silica is used in thermosets to provide dimensional stabiliy, improved thermal conductivity, and good electrical insulation properties at low cost.

Synthetic silicas are used in adhesives, caulks and sealants to control flow and sag, improve bond strength, and provide reinforcement. Fine-ground silica is used for its low moisture content, low cost, low binder demand, and to improve tensile strength without affecting flexibility or durability.

Talc

Talc's principal use in coatings is for sheen control. It also contributes to TiO_2 extension, suspension stability, flatting, chemical resistance, leveling, film integrity and weatherability.

Micronized talc is used for pitch adsorption in pulp and paper mills because of its low abrasion and its ability to preferentially wet oily materials in the presence of water. In paper and paper coatings, high purity, high brightness talc is used for TiO_2 extension and for improved gloss, opacity, brightness, and ink holdout.

Talc is used to reinforce and/or fill both thermosets and thermoplastics, although principally the latter to control melt flow, reduce creep in molded parts, increase molding cycles, increase heat deflection temperature and improve dimensional stability. Its single largest use is in polypropylene to increase both stiffness and resistance to high temperature creep.

Talc is also used as a functional filler in adhesives and sealants, as a wicking preventer in automotive undercoatings, as a filler in carpet and textile backings and as a filler and dusting agent for rubber.

Wollastonite

Wollastonite is used in coatings as an extender pigment, and to provide resistance to flash and early rust. Its acicular nature imparts film durability and superior scrub resistance. Fine-ground and micronized grades provide smooth flow, water resistance, improved wet adhesion, and good gloss in epoxy powder coatings. Acicular grades impart mud-crack resistance to texture paints.

Wollastonite is used as a reinforcing filler in plastics because of its low oil and moisture absorption, high brightness and acicularity, and availability with a variety of surface treatments. High aspect ratio wollastonite is a lower cost alternative or complement to short-milled glass fibers for both thermoplastics and thermosets, and is used together with organic and metallic fibers in asbestos-free formulations for friction products such as clutches, brake linings and brake pistons. It is also used as an asbestos substitute in phenolic molding compounds and as a reinforcing filler in nylons, particularly high-impact and platable compounds.

Wollastonite is a white reinforcing filler in adhesives and sealants, where it can be used at high loadings. Powder and fine particle sized high aspect ratio grades are used as semi-reinforcing fillers in rubber.

Filler Minerals from R.T. Vanderbilt Company, Inc.

Typical Properties	GE Brightness	<325 mesh,%	Median P.S., µm	Hegman Fineness	pH[A]	Oil Absorption, %
Kaolin Clay (Hard Clay)						
DIXIE CLAY®	70	99.8	0.2	--	4.5	41
PAR®	68	99.5	0.2	--	4.8	40
BILT-PLATES® 156	75	99.95	0.2	4	4.5	41
Kaolin Clay (Soft Clay)						
LANGFORD™	69	99.0	1.3	--	4.8	36
McNAMEE®	75	99.7	1.2	2	4.8	35
PEERLESS® 1	75	99.6[B]	1.2	0	4.6	30
PEERLESS 3	60	99.6[B]	1.1	0	4.6	33
Pyrophyllite						
PYRAX® A	65	90.0	10.0	0	6.9	24
PYRAX B	78	95.0	10.0	0	6.9	26
PYRAX WA	78	87.0	14.0	0	6.6	24
VEECOTE®	80	99.0	10.0	0-1	6.9	26
Talc						
VANTALC® 2500	80	98.8[B]	18.9	0	9.4	26
VANTALC 2000	87	93.3	9.8	0	9.4	36
VANTALC 3500	84	99.75	8.5	4	9.4	38
VANTALC 3100	87	99.9	7.8	3¼	9.4	36
VANTALC 3000	83	99.9	6.7	3½	9.4	42
VANTALC 4500	83	trace	4.2	5	9.4	44
VANTALC 4000	85	99.9	3.6	5	9.4	52
VANTALC F2504	89	99.99	3.9	5	9.4	42
VANTALC R	90	99.99	2.5	5+	9.4	48
VANTALC PC	86	99.99	2.3	5	9.4	37
VANTALC 6H-II	91	99.99	1.0	6	9.4	55
Wollastonite						
VANSIL® W-10	87	97.3[B]	15.6	0	10.0	19
VANSIL W-20	87	98.0	9.7	0-1	10.0	20
VANSIL W-30	87	99.9	4.5	4	10.0	21
VANSIL W-40	87	99.97	5.6	5	10.0	26
VANSIL W-50	87	99.99[C]	2.8	6+	10.0	30
VANSIL WG[1]	87	80.0[B]	--	0	10.0	40
VANSIL HR-325[2]	87	99.95	2.3	3	10.0	40
VANSIL HR-1500[3]	87	97.5[B]	9.0	7	10.0	44

Most wollastonite products are available with silane treatments under the **VANCOTE®** trade name.

[1]Acicular; 15:1 aspect ratio
[2]Acicular; 12:1 aspect ratio
[3]Acicular; 14:1 aspect ratio

[A]10% slurry
[B]<200 mesh
[C]<400 mesh

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