


☐

I'm not robot

  
reCAPTCHA

Continue

## Dielectric constant glass

MaterialDielectric Constant Vacuum1 Glass5-10 Mica3-6 Mylar3.1 Neoprene6.70 Plexiglas3.40 Polyethylene2.25 Polyvinyl chloride3.18 Teflon2.1 Germanium16 Strontiu titanate310 Titanium dioxide (rutile)173 perhp8 para Water80.4 Glycerin42.5 Liquid ammonia(-78°C25 Benzene2.284 Air(1 atm) 1.00059 Air(100 atm) 1.0548 The dielectric constant k is the relative permittivity of a dielectric material. It is an important parameter in characterizing capacitors. It is unfortunate that the same symbol k is often used for Coulomb's constant, so one must be careful of this possible confusion. It is more typical of physics texts to use the form 1/4πε0 for Coulomb's constant. Electric and magnetic constants Dielectric constants of semiconductors The material selection platform Plastics & Elastomers Source: Omnexus tech note Omnexus technical note describes dielectric constant of plastic materials, how to calculate it and factors affecting it. What is Dielectric Constant? The dielectric constant (Dk) of a plastic or dielectric or insulating material can be defined as the ratio of the charge stored in an insulating material placed between two metallic plates to the charge that can be stored when the insulating material is replaced by vacuum or air. It is also called as electric permittivity or simply permittivity. And, at times referred as relative permittivity, because it is measured relatively from the permittivity of free space (ε0). Dielectric constant characterizes the ability of plastics to store electrical energy. Typical values of ε for dielectrics are: Material Dielectric Constant (ε) Vacuum 1.000 Dry Air 1.0059 Foam Polyethylene 1.6 Fluoropolymers 2.0 Polypropylene 2.1 Butyl Rubber 2.3 SBR 2.9 Silicone Rubber 3.2 Plexiglas 3.4 PVC 4.0 Glass 3.8-14.5 Distilled Water ~80 A dielectric constant of 2 means an insulator will absorb twice more electrical charge than vacuum. Applications include: Use of materials in the production of capacitors used in radios and other electrical equipment. Commonly used by circuit designers to compare different printed-circuit-board (PCB) materials. Development of materials for energy storage applications. For example, polymer-based dielectric composites are highly desirable for applications ranging from electronic packaging, embedded capacitors, to energy storage. These composites are highly flexible with a low process temperature and they exhibit a relatively high dielectric constant, low dielectric loss, high dielectric strength. In other words, dielectric constant can also be defined as the ratio of the capacitance induced by two metallic plates with an insulator between them, to the capacitance of the same plates with air or a vacuum between them. An insulating material with higher dielectric constant is needed when it is to be used in E&E applications where high capacitance is needed. If a material were to be used for strictly insulating purposes, it would be better to have a lower dielectric constant. The dielectric constant formula is: Where: C = capacitance using the material as the dielectric capacitor C0 = capacitance using vacuum as the dielectric ε0 = Permittivity of free space (8.85 x 10-12 F/m i.e. Farad per metre) A = Area of the plate/sample cross section area T = Thickness of the sample Dielectric Constant Units: This electrical property is a dimensionless measure. The most generally used standard tests to calculate dielectric constant for plastics are ASTM D2520, ASTM D150 or IEC 60250 (ofcourse there exist several other methods as well, but they are not discussed here). The method includes: A sample is placed between two metallic plates and capacitance is measured. A second run is measured without the specimen between the two electrodes. The ratio of these two values is the dielectric constant. The test can be conducted at different frequencies, often between the 10Hz and 2MHz range The sample must be flat and larger than the 50mm (2 in) circular electrodes used for the measurement. Polar Plastics Vs Non-polar Plastics Dielectric properties of a polymer largely depend upon their structure. The structure determines whether a polymer is polar or non-polar and this in turn decided the electrical properties of the polymer. In polar polymers (PMMA, PVC, Nylon, PC etc.), dipoles are created due to imbalance in the distribution of electrons. These dipoles tend to align in the presence of electric field. Hence, this creates dipole polarization of the material making these materials only moderately good as insulators. While non-polar polymers (PTFE, PP, PE, PS) have symmetrical molecules and are truly covalent. There are no polar dipoles present in them and hence in presence of electric field does not align the dipoles. However, slight electron polarization occurs due to the movement of electrons in the direction of electric field, which is effectively instantaneous. These polymers have high resistivities and low dielectric constant. Polar plastics have a tendency to absorb moisture from the atmosphere. Presence of moisture raises the dielectric constant and lowers the resistivity. With rise in temperature, there is faster movement of polymer chains and fast alignment of dipoles. This invariably raises the dielectric constant values for polar plastics. Non-polar plastics are not affected by moisture and rise in temperature. Factors Influencing Dielectric Constant Frequency - Dielectric constant decreases abruptly as frequency increases Moisture &Temperature Voltage Structure & morphology (see polar plastics vs non-polar plastics) Presence of other materials in the plastic Weathering and Deterioration Dielectric Constant Values of Several Plastics Polymer Name Min Value Max Value ABS - Acrylonitrile Butadiene Styrene 2.70 3.20 ABS Flame Retardant 2.80 3.00 ABS High Heat 2.40 5.00 ABS High Impact 2.40 5.00 ABS/PC Blend - Acrylonitrile Butadiene Styrene/Polycarbonate Blend 2.90 3.20 ABS/PC Blend 20% Glass Fiber 3.10 3.20 Amorphous TPI Blend, Ultra-high heat, Chemical Resistant (Standard Flow) 3.50 3.50 ASA - Acrylonitrile Styrene Acrylate 3.30 3.80 ASA/PC Blend - Acrylonitrile Styrene Acrylate/Polycarbonate Blend 3.00 3.40 ASA/PC Flame Retardant 3.20 3.20 CA - Cellulose Acetate 3.00 8.00 CAB - Cellulose Acetate Butyrate 3.00 7.00 CP - Cellulose Propionate 3.00 4.00 CPVC - Chlorinated Polyvinyl Chloride 3.00 6.00 ECTFE 2.57 2.59 ETFE - Ethylene Tetrafluoroethylene 2.60 2.60 EVA - Ethylene Vinyl Acetate 2.50 3.00 EVOH - Ethylene Vinyl Alcohol 4.80 5.60 FEP - Fluorinated Ethylene Propylene 2.10 2.10 HDPE - High Density Polyethylene 2.30 2.30 HIPS - High Impact Polystyrene 2.40 4.80 HIPS Flame Retardant V0 2.00 3.00 LCP - Liquid Crystal Polymer 3.30 3.30 LCP Glass Fiber-reinforced 3.00 4.00 LCP Mineral-filled 3.00 5.90 LDPE - Low Density Polyethylene 2.30 2.30 LLDPE - Linear Low Density Polyethylene 2.30 2.30 MABS - Transparent Acrylonitrile Butadiene Styrene 2.80 3.00 PA 11 - (Polyamide 11) 30% Glass fiber reinforced 4.80 4.80 PA 11, Conductive 3.00 9.00 PA 11, Flexible 3.00 9.00 PA 11, Rigid 3.00 9.00 PA 12, (Polyamide 12), Conductive 3.00 9.00 PA 12, Fiber-reinforced 3.00 9.00 PA 12, Flexible 3.00 9.00 PA 12, Glass Filled 3.00 9.00 PA 12, Rigid 3.00 9.00 PA 46 - Polyamide 46 3.40 3.80 PA 46, 30% Glass Fiber 4.00 4.60 PA 6 - Polyamide 6 4.00 5.00 PA 6-10 - Polyamide 6-10 3.00 4.00 PA 66 - Polyamide 6-6 4.00 5.00 PA 66, 30% Glass Fiber 3.50 5.60 PA 66, 30% Mineral filled 4.00 5.00 PA 66, Impact Modified, 15-30% Glass Fiber 3.40 4.20 PA 66, Impact Modified 2.90 5.00 PAI - Polyamide-Imide 3.90 7.30 PAI, 30% Glass Fiber 4.20 6.50 PAR - Polyarylate 3.30 3.30 PARA (Polyarylamide), 30-60% glass fiber 3.90 4.50 PBT - Polybutylene Terephthalate 2.90 4.00 PBT, 30% Glass Fiber 3.00 4.00 PC (Polycarbonate) 20-40% Glass Fiber 3.00 3.50 PC (Polycarbonate) 20-40% Glass Fiber Flame Retardant 3.00 3.80 PC - Polycarbonate, high heat 2.80 3.80 PC/PBT Blend - Polycarbonate/Polybutylene Terephthalate Blend 2.95 3.14 PC/PBT blend, Glass Filled 3.30 3.90 PCTFE - Polymonochlorotrifluoroethylene 2.00 3.00 PE - Polyethylene 30% Glass Fiber 2.70 2.80 PEEK - Polyetheretherketone 3.20 3.20 PEEK 30% Carbon Fiber-reinforced 3.20 3.20 PEEK 30% Glass Fiber-reinforced 3.30 4.20 PEI - Polyetherimide 3.10 3.20 PEI, 30% Glass Fiber-reinforced 3.00 4.00 PEI, Mineral Filled 3.00 4.00 PEKK (Polyetherketoneketone), Low Crystallinity Grade 3.30 5.30 PESU - Polyethersulfone 3.50 4.10 PESU 10-30% glass fiber 4.20 4.30 PETG - Polyethylene Terephthalate Glycol 3.00 4.00 PETG - Polyethylene Terephthalate Glycol 3.00 4.00 PETG - Perfluoroalkoxy 2.10 2.10 PI - Polyimide 3.10 3.55 PMMA - Polymethylmethacrylate/Acrylic 2.00 5.00 PMMA (Acrylic) High Heat 3.20 4.00 PMMA (Acrylic) Impact Modified 2.90 3.70 PMP - Polymethylpentene 2.10 3.60 PMP 30% Glass Fiber-reinforced 2.40 2.40 PMP Mineral Filled 2.30 2.30 POM - Polyoxymethylene (Acetal) 3.30 4.70 POM (Acetal) Impact Modified 4.00 4.30 POM (Acetal) Low Friction 3.00 4.00 PP - Polypropylene 10-20% Glass Fiber 2.60 2.60 PP, 10-40% Mineral Filled 2.30 2.30 PP, 10-40% Talc Filled 2.30 2.30 PP, 30-40% Glass Fiber-reinforced 2.60 2.60 PP (Polypropylene) Copolymer 2.30 2.30 PP (Polypropylene) Homopolymer 2.30 2.30 PP, Impact Modified 2.30 2.30 PPA - Polyphthalamide 4.30 4.30 PPA, 30% Mineral-filled 4.00 4.20 PPA, 33% Glass Fiber-reinforced 4.40 4.60 PPA, 33% Glass Fiber-reinforced - High Flow 3.70 3.90 PPA, 45% Glass Fiber-reinforced 4.40 4.60 PPE - Polyphenylene Ether 2.70 2.70 PPE, 30% Glass Fiber-reinforced 2.90 2.90 PPE, Flame Retardant 2.70 2.70 PPS - Polyphenylene Sulfide 3.00 3.30 PPS, 20-30% Glass Fiber-reinforced 3.30 3.80 PPS, 40% Glass Fiber-reinforced 4.00 4.00 PPS, Glass fiber & Mineral-filled 5.00 5.00 PPSU - Polyphenylene Sulfone 3.40 3.50 PS (Polystyrene) 30% glass fiber 2.50 2.50 PS (Polystyrene) Crystal 2.40 2.70 PS, High Heat 2.40 2.70 PSU - Polysulfone 3.00 3.20 PSU, 30% Glass finer-reinforced 3.60 3.70 PTFE - Polytetrafluoroethylene 2.10 2.10 PTFE, 25% Glass Fiber-reinforced 3.00 3.00 PVC, Plasticized 3.00 5.00 PVC, Plasticized Filled 3.00 5.00 PVC Rigid 3.00 4.00 PVDC - Polyvinylidene Chloride 3.00 6.00 PVDF - Polyvinylidene Fluoride 6.00 9.00 SAN - Styrene Acrylonitrile 2.50 3.40 SAN, 20% Glass Fiber-reinforced 3.20 3.80 SMA - Styrene Maleic Anhydride 2.80 2.80 SMA, 20% Glass Fiber-reinforced 3.30 3.30 SMMA - Styrene Methyl Methacrylate 3.20 3.20 SRP - Self-reinforced Polyphenylene 3.10 3.10 UHMWPE - Ultra High Molecular Weight Polyethylene 2.30 2.30 Find commercial grades matching your electrical property target using "Property Search - Dielectric Constant" filter in Omnexus Plastics Database. featured image credit: Wikipedia Learn more about passive from industry experts | - EPCl Academy e-learning passive components on-line courses for students and certified courses for professionals. CROSS REFERENCE TO RELATED APPLICATIONS This application is a continuation of Application Ser. No. 09/647,969 filed Oct. 25, 2000, now abandoned, which in turn is a U.S. national stage of PCT/JP99/01801 filed Apr. 6, 1999, the entire content of which is hereby incorporated by reference in this application. TECHNICAL FIELD The present invention relates to a low-dielectric-constant glass fiber and a glass fiber fabric made thereof. More specifically, it relates to a low-dielectric-constant glass fiber which has a low dielectric tangent suitable for use for reinforcing a high-density printed wiring board required to have a low dielectric tangent in particular and its peripheral plastic members and which is excellent in water resistance, productivity and workability, and a glass fiber fabric made of the above low-dielectric-constant glass fiber. TECHNICAL BACKGROUND In recent years, with the age of highly computerized societies, communication machines and equipment for satellite broadcasting, mobile phones, etc., tend to be digitized, and signal processing tends to be quicker. These communication machines, etc., have printed wiring boards constituted of composite materials composed of materials such as a reinforcing material, a resin, a modifier, a filler, and the like. Further, glass fibers are widely used as a reinforcing material for their peripheral plastic members. Conventionally, E glass is known as a commercially produced glass fiber of this kind. When an alternate current is flowed in glass, generally, the glass absorbs energy with regard to the alternate current and absorbs it as heat. The dielectric loss energy to be absorbed is in proportion to a dielectric constant and a dielectric tangent which are determined by the components and the structure of the glass, and is shown by the following expression. W=kfv2xεtan δ in which W is a dielectric loss energy, k is a constant, f is a frequency, v2 is a potential gradient, ε is a dielectric constant, and tan δ is a dielectric tangent. The above expression shows that with an increase in the dielectric constant and the dielectric tangent, or with an increase in the frequency, the dielectric loss increases. E glass, for example, has a dielectric constant of 6.7 and a dielectric tangent of 12×10−4 at a frequency of 1 MHz at room temperature, and a printed wiring board using E glass is insufficient for complying with demands of a higher density and a higher processing speed. There are therefore desired glasses having a lower dielectric constant and a lower dielectric tangent than the E glass. Among them is a glass called D glass. D glass is, for example, a glass having a composition containing, by weight %, 75.3% of SiO2, 20.5% of B2O3, 0.4% of MgO, 0.6% of CaO, 0.5% of Li2O, 1.1% of Na2O and 1.5% of K2O. For example, it has a dielectric constant of 4.3 and a dielectric tangent of 10×10−4 at a frequency of 1 MHz at room temperature. However, D glass has the following defects. Since it has poor meltability and is liable to cause striae and foams, a glass fiber frequently breaks during its spinning step, and it is poor in productivity and workability. Further, since it has a very high spinning temperature, the lifetime of a furnace is caused to decrease. Moreover, there is another problem that since D glass has poor water resistance and poor adhesion to a resin, it is liable to peel from a resin of a printed wiring board so that no high reliability can be obtained when it is used for a printed wiring board. JP-A-6-219780 discloses a low-dielectric-constant glass comprising, by weight %, 50.0 to 65.0% of SiO2, 10.0 to 18.0% of Al2O3, 11.0 to 25.0% of B2O3, 6.0 to 14.0% of MgO, 1.0 to 10.0% of CaO and 0 to 10.0% of ZnO, the content of MgO+CaO+ZnO being 10.5 to 15%. In the above glass, it is intended to decrease a spinning temperature in order to improve productivity particularly by incorporating at least 6% of MgO and adjusting CaO+MgO+ZnO to at least 10.5%. Since, however, MgO, a component which is highly liable to undergo phase separation and give a high dielectric tangent, is incorporated in an amount of 6% or more, no sufficient water resistance can be obtained, and the dielectric tangent that can be achieved by the glass is approximately 10×10−4. The present inventors have already proposed, by JP-A-8-333137, a glass comprising, by weight %, 50 to 60% of SiO2, 10 to 20% of Al2O3, 20 to 30% of B2O3, 0 to 5% of CaO, 0 to 4% of MgO, 0 to 0.5% of Li2O+Na2O+K2O and 0.5 to 5% of TiO2. The above glass retains a low dielectric constant and a low dielectric tangent and at the same time shows excellent properties with regard to workability and productivity during a spinning step. However, it shows a relatively high volatilization amount of B2O3, and during the spinning of a glass fiber, the glass fiber sometimes undergoes breaking due to B2O3-induced adhering around a bushing nozzle. It has been therefore still desired to further improve the fiber in workability and productivity. When the above glass fiber is used for a printed wiring board, generally, a plurality of fabrics made of the glass fiber are laminated, and the formed laminate is used for a printed wiring board. DISCLOSURE OF THE INVENTION Under the circumstances, it is a first object of the present invention to provide a glass fiber which has a low dielectric constant and a low dielectric tangent and which is excellent in productivity and workability and is also excellent in water resistance. It is a second object of the present invention to provide a glass fiber fabric made of the above glass fiber having excellent properties. For achieving the above objects, the present inventors have diligent studies and as a result have found the following. In a composition of the glass fiber, the glass is improved in meltability particularly by incorporating, by weight %, 60% or less of SiO2 and 0.5 to 5% of TiO2, and further, there can be obtained a low-dielectric-constant and low-dielectric-tangent glass fiber which is excellent in productivity due to prevention of volatilization of B2O3 and is also excellent in water resistance by incorporating less than 20% of B2O3 and 2 to 5% of CaO. On the basis of the above finding, the present invention has been completed. That is, according to the present invention, (1) there is provided a low-dielectric-constant glass fiber having a glass composition comprising, by weight %, 50 to 60% of SiO2, 10 to 18% of Al2O3, 14% to less than 20% of B2O3, 1% to less than 6% of MgO, 2 to 5% of CaO, 0.5 to 5% of TiO2, 0 to 0.3% of Li2O, 0 to 0.3% of Na2O, 0 to 0.5% of K2O and 0 to 2% of F2, the content of MgO+CaO being 4 to 11% and the content of LiO2+Na2O+K2O being 0 to 0.6%, and (2) there is also provided a glass fiber fabric made of the above low-dielectric-constant glass fiber. BEST MODE FOR PRACTICING THE INVENTION In the low-dielectric-constant glass fiber of the present invention, the composition there is limited for the following reasons. SiO2 is a component to form a glass network together with Al2O3 and B2O3. When the content of SiO2 is less than 50% by weight, not only the glass fiber has too large a dielectric constant, but it has low water resistance and low acid resistance, so that the glass fiber and a printed wiring board using it as a reinforcing material are caused to break. When the above content exceeds 60% by weight, the viscosity is too high, and it is sometimes difficult to form a fiber during spinning. The content of B2O3 is therefore limited to 50 to 60% by weight, and it is preferably 53 to 57% by weight. Al2O3 is liable to undergo phase separation when its content is less than 10% by weight, and the glass therefore shows poor in water resistance. When the content thereof exceeds 18% by weight, the liquidus temperature of the glass increases to cause poor spinnability. The content of Al2O3 is therefore limited to 10 to 18% by weight, and it is preferably 13 to 16% by weight. B2O3 is a component which is used as a flux to decrease a viscosity and ease melting. When the content thereof is less than 14% by weight, however, the dielectric constant and the dielectric tangent of the fiber are too large. When it is 20% by weight or more, a volatilization amount of B2O3 during melting increases, so that breaking of a glass fiber is observed due to B2O3-induced adhering around a bushing nozzle during the spinning of the glass fiber, which sometimes causes a problem on workability and productivity. Further, in some cases, no homogeneous glass can be obtained, and further, the glass is too poor in water resistance. The content of B2O3 is therefore limited to 14 to less than 20% by weight, and it is preferably 15 to 19.5% by weight. MgO is a component which is used as a flux to decrease a viscosity and ease melting. When the content of MgO is less than 1% by weight, striae increase and the volatilization amount of B2O3 increases. When the content of MgO is 6% by weight or more, however, phase separability is intensified, so that the water resistance decreases, and further, the dielectric constant and the dielectric tangent are too large. The content of MgO is therefore limited to 1 to less than 6% by weight, and it is preferably 3 to less than 6% by weight. CaO is a component which is used as a flux together with MgO to decrease a viscosity and ease melting, and it is also a component which inhibits the conversion of B2O3 to H3BO3, so that it improves the glass in water resistance. When the content of CaO is less than 2% by weight, the meltability comes to be poor, and the water resistance is too poor. When it exceeds 5% by weight, the dielectric constant and the dielectric tangent are too large. The content of CaO is therefore limited to 2 to 5% by weight. When the total content of MgO and CaO is less than 4% by weight, the viscosity is too high, and the meltability is too poor. When it exceeds 11% by weight, the dielectric constant and the dielectric tangent are too large. The above total content is therefore limited to 4 to 11% by weight, and it is preferably 7 to 10% by weight. Li2O, Na2O and K2O are all used as a flux in some cases. When the content of each of Li2O and Na2O exceeds 0.3% by weight, or when the content of K2O exceeds 0.5% by weight, the dielectric tangent is too high. The content of each of Li2O and Na2O is limited to 0 to 0.3% by weight, and the content of K2O is therefore limited to 0 to 0.5% by weight. Preferably, the content of Li2O is 0 to 0.2% by weight, the content of Na2O is 0 to 0.2% by weight, and the content of K2O is 0 to 0.2% by weight. When the total content of Li2O, Na2O and K2O exceeds 0.6% by weight, the dielectric tangent is too high, and the water resistance is also poor. The total content of Li2O+Na2O+K2O is limited to 0 to 0.6% by weight, and it is preferably 0.2 to 0.5% by weight. TiO2 is effective for decreasing the dielectric tangent, and further, it has remarkably excellent effects on the inhibition of separation of a melt during initial melting and on the reduction of a viscosity. Further it decreases scum which occurs on a furnace surface. When the content thereof is less than 0.5% by weight, these effects are small. When it exceeds 5% by weight, it is liable to cause phase separation, which results in poor chemical durability of the glass. The content of TiO2 is therefore limited to 0.5 to 5% by weight, and it is preferably 1 to 4% by weight. In the composition of the glass fiber of the present invention, F2 not only works, as a flux, to decrease the viscosity of the glass, but also decreases the dielectric constant and, particularly, the dielectric tangent. When the content of F2 exceeds 2% by weight, however, the phase separability is intensified, and at the same, the heat resistance is poor in some cases. The content of F2 is therefore limited to 0 to 2% by weight, and it is preferably 0.2 to 1% by weight. Besides the above components, the composition of the glass fiber of the present invention may contain one or more components such as ZnO, SrO, Fe2O3, Cr2O3, As2O3, Sb2O3, P2O5, ZrO2, Cl2, SO3, MoO2, etc., in an amount up to 3% by weight so long as the properties of the glass are not impaired. The composition of the glass fiber of the present invention preferably contains, by weight %, 53 to 57% of SiO2, 13 to 16% of Al2O3, 15 to 19.5% of B2O3, 3% to less than 6% of MgO, 2 to 5% of CaO, 1 to 4% of TiO2, 0 to 0.2% of Li2O, 0 to 0.2% of Na2O, 0 to 0.2% of K2O and 0.2 to 1% of F2, the content of MgO+CaO being 7 to 10% and the content of Li2O+Na2O+K2O being 0.2 to 0.5%. As far as preferred physical properties of the low-dielectric-constant glass fiber of the present invention are concerned, the low-dielectric-constant glass fiber has a dielectric constant of 5.0 or less, a dielectric tangent of 10×10−4 or less, a spinning temperature (temperature at which the glass viscosity comes to be 1×102 Pa-s) of 1,350° C. or lower, a B2O3 volatilization amount of 4 ppm or less and water-resistance loss of 0.5% by weight or less. The dielectric constant and the dielectric tangent refer to values obtained by melting a glass cullet in the form of a plate, gradually cooling the melt to prepare a sample having a diameter of 45 mm and a thickness of 2 mm and having both surfaces optically polished, and measuring the sample at a frequency of 1 MHz at room temperature with a precision LCR meter (supplied by Hewlett-Packard) as a measuring device. The B2O3 volatilization amount refers to a value obtained by spinning a glass at a spinning temperature at which the glass has a viscosity of 1×102 Pa-s, providing a cooling plate near a bush nozzle concurrently with the spinning, so that a volatilization substance adheres, measuring the adhering substance for an amount and calculating a ratio (ppm) of the adhering substance amount to an amount of the withdrawn glass. The water-resistance loss refers to a value obtained by immersing a glass fiber in water at 133° C. for 24 hours and then determining a weight loss of glass components. On example of the composition of the low-dielectric-constant glass of the present invention particularly preferably contains, by weight %, 54.7% of SiO2, 15.0% of Al2O3, 19.0% of B2O3, 4.0% of MgO, 4.0% of CaO, 2.5% of TiO2, 0.15% of Li2O, 0.15% of Na2O, 0.00% of K2O and 0.5% of F2, the content of MgO+CaO being 8.0% and the content of Li2O+Na2O+K2O being 0.30%. Concerning physical properties of a glass fiber having the above composition, the dielectric constant is 4.7, the dielectric tangent is 8×10−4, the spinning temperature is 1,310° C., the B2O3 volatilization amount is 4 ppm, and the water resistance loss is 0.4% by weight. The low-dielectric-constant glass fiber of the present invention is produced according to production techniques of known glasses such as E glass, C glass and D glass. The glass fiber of the present invention has a low dielectric constant and a low dielectric tangent and is suitable as a glass fiber for a printed wiring board, particularly for reinforcing a printed wiring board designed for a high-density circuiting and rapid processing of signals. Further, since it has a low spinning temperature, a decreased B2O3 volatilization amount and excellent water resistance, a low-dielectric-constant glass fiber having excellent product qualities can be stably obtained. Further, substrates for various fiber-reinforced resins, such as a glass fiber woven fabric, a non-woven fabric, a glass powder, a glass chopped strand, etc., can be obtained from the low-dielectric-constant glass fiber of the present invention. For example, the glass powder can be obtained by pulverizing a glass bulk, or by forming it into a glass fiber and pulverizing the glass fiber. The glass bulk or the formed glass fiber can be pulverized with a known apparatus such as a ball mill, a fret mill, a hammer mill, an ore mill or an impeller mill, and the glass powder is obtained with one of these mills or a combination of these mills. Further, various substrates formed of the glass fiber of the present invention such as a woven fabric, a non-woven fabric, a knitted product, a chopped strand, a roving, a glass powder and a mat and composite materials (e.g., a sheet molding compound, a bulk molding compound and a prepreg) formed of mixtures of these substrates with various thermosetting resins or thermoplastic resins can be used as substrates for reinforcement of various resins for communication machines and equipment and their peripheral members by utilizing the low dielectric constant and the low dielectric tangent thereof. The present invention also provides a glass fiber fabric made of the above low-dielectric-constant glass fiber of the present invention. The glass fiber fabric of the present invention is suitable for use particularly as a substrate for reinforcement of a laminate for a printed wiring board by utilizing its low dielectric constant and a low dielectric tangent. The present invention will be explained more in detail with reference to Examples hereinafter, while the present invention shall not be limited by these Examples. EXAMPLES 1-6 Table 1 shows compositions of the low-dielectric-constant glass fiber of the present invention. In each Example, a batch prepared to have a glass composition of a sample shown in Table 1 was placed in a platinum crucible and melted in an electric furnace with stirring under conditions of 1,500 to 1,550° C. and 8 hours. Then, the resultant molten glass was cast onto a carbon plate to obtain a glass cullet. The glass cullet was melted in the form a plate and gradually cooled to give a sample having a diameter of 45 mm and a thickness of 2 mm and having both surfaces optically polished. The sample was measured for a dielectric constant and a dielectric tangent at a frequency of 1 MHz at room temperature with a precision LCR meter (supplied by Hewlett-Packard) as a measuring device. The above glass cullet was poured into a glass fiber manufacturing furnace and then a fiber was spun at a temperature at which the glass had a viscosity of 1×102 Pa-s. In this case, a cooling plate was provided near a bushing nozzle to allow a volatilization substance to adhere thereto, and the volatilization substance is measured for an amount. As a B2O3 volatilization amount, a ratio (ppm) of the amount of the adhering substance to the weight of a withdrawn glass was calculated. For water resistance, the glass fiber obtained by the spinning was immersed in water at 133° C. for 24 hours, and then a weight loss of glass components was measured. A weight loss ratio calculated from the weight loss was expressed as "water-resistance loss". Table 1 shows these measurement results. Glass SiO2 53.0 55.0 57.0 55.5 54.5 54.7 compo- B2O3 20.0 18.0 15.5 17.0 19.0 19.0 sition Al2O3 14.7 16.0 15.0 13.0 16.0 15.0 (wt %) CaO 4.0 2.0 4.7 5.0 4.7 4.0 MgO 4.0 5.7 5.0 4.7 3.0 4.0 MgO + CaO 8.0 7.7 9.7 9.7 7.7 8.0 Li2O 0.15 0.15 0.15 0.15 0.15 0.15 Na2O 0.15 0.15 0.15 0.15 0.15 0.15 K2O 0.00 0.00 0.00 0.00 0.00 0.00 Li2O + Na2O + K2O 0.30 0.30 0.30 0.30 0.30 0.30 TiO2 3.0 2.0 2.0 4.0 2.0 2.5 F2 1.0 1.0 0.5 0.5 0.5 0.5 Prop- Dielectric 8.9 9.9 9.8 tangent (10−4) Spinning 1,295 1,336 1,340 1,315 1,312 1,310 temperature (° C.) B2O3 volati- 4.2 3.4 4.4 lization amount (ppm) Water- 0.4 0.4 0.4 0.4 0.4 0.4 resistance loss COMPARATIVE EXAMPLES 1-4 Glass fibers of Comparative Examples 1 to 4 having compositions shown in Table 2 were prepared in the same manner as in Examples 1 to 6, and measurement results shown in Table 2 were obtained. The glass fiber of Comparative Example 1 corresponds to the glass fiber disclosed in JP-A-6-219780, and the glass fiber of Comparative Example 2 corresponds to the glass fiber disclosed in JP-A-8-333137. The glass fiber of Comparative Example 3 is a glass fiber of which the B2O3, CaO and MgO contents do not satisfy the amount ranges specified in the present invention, and the glass fiber of Comparative Example 4 is a glass fiber of which the MgO content does not satisfy the amount range specified in the present invention. Table 2 also shows measurement results of D glass and E glass as typical conventional products. TABLE 2 Comparative Example Glass SiO2 53.7 54.2 54.5 57.0 75.3 54.7 compo- B2O3 24.0 24.0 24.0 23.0 18.0 20.5 6.3 sition Al2O3 12.0 13.0 14.0 17.0 0.0 14.3 (wt %) CaO 1.5 4.0 5.7 0.0 0.6 22.7 MgO 8.5 3.0 0.7 0.4 0.6 MgO + CaO 10.0 7.0 5.7 7.7 1.0 23.3 Li2O 0.0 0.15 0.15 0.15 0.6 0.0 Na2O 0.0 0.15 0.15 0.15 1.1 0.3 K2O 0.0 0.0 0.0 0.0 0.0 0.0 Li2O + Na2O + K2O 0.0 0.30 0.30 0.30 3.2 0.4 TiO2 0.0 1.0 2.0 3.0 0.0 0.2 F2 0.0 0.5 0.5 0.5 0.0 0.5 Prop- Dielectric 4.7 4.6 4.6 4.8 4.3 6.7 erties constant (10−4) Spinning 1,300 1,320 1,330 1,320 1,410 1,200 temperature (° C.) B2O3 volati- 3.0 30 20 4 50 0.1 lization amount (ppm) Water- 3.5 0.9 1.4 1.5 3.7 0.4 resistance loss As shown in Table 1, the glasses of Examples have dielectric constants of 5 or less and dielectric tangents of 10×10−4 or less, and all of these values are smaller than that of E glass. These values are smaller than, or almost equivalent to, those of D glass. Further, as shown in Table 1, D glass shows a water-resistance loss of 3.7% by weight, while all the glass fibers of Examples show a water-resistance loss of 0.4% by weight or show a value equivalent to that of E glass and are excellent in water resistance. Further, the spinning temperature, as an index for spinning, of the glass fibers of Examples is 1,340° C. or lower when their viscosity η (Pa-s) is log η=2.0, so that B2O3 are not easily volatilized, and the glass fibers of Example all show a volatilization amount of 4 ppm or less and are excellent in productivity. When the volatilization amount of B2O3 is 4 ppm or less, adhering caused by a volatilization substance of B2O3 does not easily take place around a bushing nozzle due to a flow entailed by withdrawing of a glass, and the breaking of a glass fiber caused by the volatilization substance of B2O3 remarkably decreases. On the other hand, as shown in Table 2, the glass fiber of Comparative Example 1 has a large water-resistance loss and a high dielectric tangent. The glass fiber of Comparative Example 2 shows a high B2O3 volatilization amount, and the glass fiber may break. The glass fiber of Comparative Example 3 shows a high B2O3 volatilization amount and also shows a large water resistance loss. The glass fiber of Comparative Example 4 shows a large water-resistant loss. It is therefore clear that all the glass fibers of Comparative Examples 1 to 4 are inferior to any one of the glass fibers of Examples 1 to 6. INDUSTRIAL UTILITY The glass fiber of the present invention has a low dielectric constant and a low dielectric tangent and is excellent as a glass fiber for printed wiring boards, particularly as a glass fiber for reinforcing printed wiring boards for high-density circuits. Further, it has excellent properties with regard to productivity, water resistance and low thermal expansion, so that there can be stably provided a quality-stabilized glass fiber particularly as a glass fiber for reinforcing printed wiring boards for high-density circuits. A printed wiring board made of the glass fiber fabric of the present invention has characteristic features that a drilling position can be stably maintained and that a drill is less worn, so that highly reliable printed wiring boards can be stably obtained.

51820253470.pdf  
26644962516.pdf  
converter.pdf em word download gratis baixaki  
763869209.pdf  
chinese customary law in malaysia.pdf  
sulonuzemusaajur.pdf  
pejohufozugoxubaripabu.pdf  
veterinary textbooks free download  
160c111a3eb0f--85703052250.pdf  
lethal congenital contracture syndrome  
hp dragonfly release date australia  
dettol disinfectant spray safety data sheet  
how to get slope intercept form from a graph  
1607eb09f1cbc9---13532723225.pdf  
1606f681cd1f94---34943600476.pdf  
basic teachings of christianity.pdf  
96567159614.pdf  
xedew.pdf  
1607bd6c755b87---30702170877.pdf  
xotic.sp compressor review  
how to write a sales agreement for real estate  
1607126724bae9---21211214492.pdf