glass and a glass or a metal or between a metal and a metal or a ceramic and a vitrified networking reaction is allowed to proceed to complete vitrification hardening.

Also in this technology, however, when the insulating particles are hardened in a minute space, the whole body may shrink to leave a gap between the insulating layer and the substrate.

SUMMARY OF THE INVENTION

1. Insulating Paste

An insulating paste according to a first aspect~~the present invention~~ comprises insulating particles, Si particles and an organic Si compound. The organic Si compound reacts with the Si particles to form a Si-O bond filling up the space around the insulating particles. The insulating paste according to an embodiment~~the present invention~~ can be prepared by dispersing the insulating particles, the Si particles and the organic Si compound in a proper dispersion medium. The term "insulating particles" is interchangeable with the term "dielectric particles" in the sense that they can have a certain relative permittivity.

2. Method for Forming Insulator

According to a second and a third aspects, there are provided~~In a~~ method~~s~~ for forming an insulator~~ according to the present invention, the insulator should be formed~~ in a minute space of an electronic device. The term "minute space" as used herein refers to a small space left between two adjacent members or a hole or groove formed in a single member.

(1) First Method

According to the second aspect, there is provided~~In~~ a first method~~,~~ for forming an~~the~~ insulator~~ is formed~~ in a~~the~~ minute space of an electronic device~~with the insulating paste according to the present invention~~. In the first method, at first, an insulating paste containing insulating particles, Si particles and an organic Si compound is poured into the minute space.

Subsequently, the organic Si compound is reacted with the Si particles by heat treatment to form a Si-O bond network filling up the space around the insulating particles.

By performing the above process with the insulating paste according to an embodiment~~the present invention~~, an insulator with excellent physical and chemical strength can be formed in the minute space.

Moreover, the Si-O bond filling up the space around metal oxide particles, more specifically, amorphous SiO_2 can be formed by reacting the organic Si compound with the Si particles. That is, since the formation of the oxide from the Si particles increases the volume, a highly reliable insulator can be formed in the minute space, which is free from defects such as a gap, a void or a crack. It should be noted that the volume of the SiO_2 increases by about 30 to 35% from that of the Si particles. This corresponds to the shrinkage ratio of the Si particles, preventing the formation of a void, a gap or a crack due to the shrinkage.

Furthermore, since the insulating paste according to an embodiment~~the present invention~~ contains the insulating particles, the insulator can be provided with various electrical properties based on the properties of the insulating particles. For instance, when the insulating particles comprise a ferroelectric material such as barium titanate, the insulator can be provided with a large capacitance; when the insulating particles comprise a low dielectric material, the insulator can be provided with a small capacitance.

(2) Second Method

According to a third aspect, there is provided~~In~~ a second method for forming the insulator in the minute space of an electronic device.~~,~~ A~~a~~t first, a silicon oil is poured into the minute space and Si particles are formed by heat treatment.

Then, an insulating paste containing insulating particles and an

organic Si compound is poured into the minute space, and subsequently, the organic Si compound is reacted with the Si particles by heat treatment to form a Si-O bond network filling up the space around the insulating particles.

The second method of the third aspect is different from the first method of the second aspect in that the silicon oil in the minute space is subjected to heat treatment to form the Si particles.

3. Electronic Device

An electronic device according to an embodiment~~the present invention~~ can be formed by the foregoing insulator forming method with the foregoing insulating paste. For example, a small insulator may be formed for a conductor or a semiconductor, or an underfill for filling up a minute gap left between stacked substrates may be formed in a multilayered electronic device.

According to a fourth aspect, there is provided an electronic device having an insulator in a minute space, wherein the insulator is formed with the insulating paste according to the first aspect.

The other objects, constructions and advantages of the present invention will be further detailed below with reference to the attached drawings. However, the attached drawings show only illustrative examples.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a drawing schematically showing the composition of an insulating paste according to the present invention.

Fig. 2 is a drawing showing a method for forming an insulator in a minute space according to the present invention.

Fig. 3 is a drawing schematically showing the structure of an insulator that is formed with an insulating paste according to the present invention.

Fig. 4 is a drawing showing another example of a method for forming an insulator in a minute space according to the present invention.