In general, in the case of a semiconductor sealing material application, if a large quantity of a sodium ion is contained, the insulating properties are deteriorated, which is not desirable. This is because if a sodium ion and a chlorine ion are contained as impurities in an epoxy resin to be used for an electronic device, these elute into the absorbed moisture to corrode metallic parts, thereby influencing electric reliability of the electronic device [see *Overview: Epoxy Resins*, Vol. 3 (published by The Japan Society of Epoxy Resin Technology, 2003, page 137)]. For that reason, even in tetramethylbiphenol type resins, so far the content of ionic impurities has been reduced as far as possible.

[0012]

However, surprisingly, the inventor of the present invention has obtained a novel finding that a tetramethylbiphenol type epoxy resin is hardly influenced by a sodium ion contained as an ionic impurity, and so long as its content is very small, the influence against the reliability is small. It may be considered that this is because in view of the fact that the tetramethylbiphenol type epoxy resin has four methyl structures, the water absorption in the ether site is hindered, and therefore, it is excellent in moisture absorption resistance. In addition, as a result of investigations made by the inventor of the present invention, there was brought a surprising effect that when a sodium ion as measured by a specified measurement method is contained in a specified proportion, the heat resistance is rather improved.

[0013]

Namely, summary of the present invention relates to the following [1] to [13].

[1] A tetramethylbiphenol type epoxy resin wherein a content of a sodium ion which is determined by the following measurement method is 1 to 12 ppm.

(Measurement Method) Measurement by the atomic absorption spectrometry using a solution wherein a sample is dissolved in N-methylpyrrolidone

[2] The tetramethylbiphenol type epoxy resin according to [1], having an epoxy equivalent ranging from 174 to 300 g/equivalent.

[3] The tetramethylbiphenol type epoxy resin according to [1] or [2], having a melt viscosity at 150°C ranging from 0.001 to 10 Pa·s.

[4] The tetramethylbiphenol type epoxy resin according to any one of [1] to [3], wherein the tetramethylbiphenol type epoxy resin contains a diglycidyl ether of 4,4'-bishydroxy-3,3',5,5'-tetramethylbiphenyl.

[5] An epoxy resin composition comprising a tetramethylbiphenol type epoxy resin and a curing agent and having a content of a sodium ion of 0.6 to 12 ppm which is determined by the following measurement method.

(Measurement Method) Measurement by the atomic absorption spectrometry using a solution wherein a sample is dissolved in N-methylpyrrolidone

[6] The epoxy resin composition according to [5], wherein an epoxy equivalent of the tetramethylbiphenol type epoxy resin ranges from 174 to 300 g/ equivalent.

anhydride, methylcyclohexene dicarboxylic anhydride, methylcyclohexene tetracarboxylic anhydride, ethylene glycol bistrimellitate dianhydride, HET anhydride, nadic anhydride, methyl nadic anhydride, 5-(2,5-dioxotetrahydro-3-furanyl)-3-methyl-3-cyclohexane-1,2-dicarboxylic anhydride, 3,4-dicarboxy-1,2,3,4-tetrahydro-1-naphthalene succinic dianhydride, 1-methyl-dicarboxy-1,2,3,4-tetrahydro-1-naphthalene succinic dianhydride, and the like.

[0078]

Examples of the modified product of an acid anhydride include those resulting from modification of the above-described acid anhydrides with a glycol, and the like. Examples of the glycol which can be used for the modification include alkylene glycols, such as ethylene glycol, propylene glycol, neopentyl glycol, *etc.*; polyether glycols, such as polyethylene glycol, polypropylene glycol, polytetramethylene ether glycol, *etc.*; and the like. Furthermore, a copolymer polyether glycol of two or more kinds of these glycols and/or polyether glycols can also be used.

[0079]

In the modified product of the acid anhydride, it is preferred that 1 mol of the acid anhydride is modified with 0.4 mol or less of the glycol. When the modification amount is the above-described upper limit value or less, the viscosity of the epoxy resin composition does not become excessively high, the workability tends to become favorable, and the rate of a curing reaction with the epoxy resin tends to become favorable.

[0080]

The above-exemplified acid anhydride curing agents may be used merely alone, or may be used in arbitrary combination of two or more thereof in an arbitrary blending ratio. In the case of using the acid anhydride-based curing agent, it is preferably used in an amount ranging from 0.8 to 1.5 in terms of an equivalent ratio of the functional group in the curing agent relative to the epoxy group in the total epoxy resin component in the epoxy resin composition. When the amount of the acid anhydride-based curing agent falls within this range, the unreacted epoxy group or the functional group of the curing agent hardly remains, and hence, such is preferred.

[0081]

<Amide-based curing agent>

Examples of the amide-based curing agent include dicyandiamide and derivatives thereof, polyamide compounds, and the like. The amide-based curing agents may be used merely alone, or may be used in arbitrary combination of two or more thereof in an arbitrary blending ratio. It is preferred to use the above-described amide-based curing agent in an amount ranging from 0.8 to 1.5 in terms of an equivalent ratio of the functional group in the curing agent relative to the epoxy group in the total epoxy resin component contained in the epoxy resin composition. When the amount of the amide-based curing agent falls within this range, the unreacted epoxy group or the functional group of the curing agent hardly retains,

and hence, such is preferred.

[0082]

<Imidazole>

Examples of the imidazole include 2-phenylimidazole, 2-ethyl-4(5)-methylimidazole, 2-phenyl-4-methylimidazole, 1-benzyl-2-methylimidazole, 1-benzyl-2-phenylimidazole, 1-cyanoethyl-2-undecylimidazole, 1-cyano-2-phenylimidazole, 1-cyanoethyl-2-undecylimidazole trimellitate, 1-cyanoethyl-2-phenylimidazolium trimellitate, 2,4-diamino-6-[2'-methylimidazolyl-(1')]-ethyl-s-triazine, 2,4-diamino-6-[2'-ethyl-4'-methylimidazolyl-(1')]-ethyl-s-triazine, a 2,4-diamino-6-[2'-methylimidazolyl-(1')]-ethyl-s-triazine isocyanuric acid adduct, a 2-phenylimidazole isocyanuric acid adduct, 2-phenyl-4,5-dihydroxymethylimidazole, 2-phenyl-4-methyl-5-hydroxymethylimidazole, adducts of an epoxy resin and the above-described imidazoles, and the like. Since the imidazole has a catalytic ability, in general, it may also be classified into a curing accelerator. However, in the present invention, it should be construed that the imidazole is classified into the curing agent.

[0083]

The above-exemplified imidazoles may be used merely alone, or may be used in arbitrary combination of two or more thereof in an arbitrary blending ratio. It is preferred to use the above-described imidazole-based curing agent in an amount ranging from 0.8 to 1.5 in terms of an equivalent ratio of the functional group in the curing agent relative to the epoxy group in the total epoxy resin component contained in the epoxy resin composition. Within this range, the unreacted epoxy group or the functional group of the curing agent hardly remains, and hence, such is preferred.

[0084]

<Other curing agent>

In the epoxy resin composition of the present invention, a curing agent other than the above-described curing agents can be used. The other curing agent which can be used for the epoxy resin composition of the present invention is not particularly limited, and all of substances which are generally known as a curing agent of epoxy resins can be used. These other curing agents may be used merely alone, or may be used in combination of two or more thereof.

[0085]

[Curing accelerator]

The epoxy resin composition of the present invention may contain a curing accelerator. Examples of the curing accelerator which is contained in the epoxy resin composition of the present invention include a phosphorus-based curing accelerator, a tetraphenylboron salt, an organic acid dihydride, a halogenated boron amine complex, and the like. These curing accelerators may be used merely alone, or may be used in arbitrary combination of two or more thereof in an arbitrary blending ratio. Among these, an epoxy

thereby obtaining an epoxy resin composition. This was heated and cured at 120°C for 2 hours and subsequently at 175°C for 6 hours, thereby obtaining a cured product. In Table 2, the term "parts" means "parts by weight".

[0130]

The curing agent and the phosphorus-based curing accelerator used are as follows.

Curing agent: Phenol novolak resin (a trade name: RESITOP PSM6200 (hydroxyl group equivalent: 103 g/equivalent, softening point: 85°C), manufactured by Gunei Chemical Industry Co., Ltd.)

Phosphorus-based curing accelerator: Triphenylphosphine (a trade name: Triphenylphosphine, manufactured by Tokyo Chemical Industry Co., Ltd.)

[0131]

All of the above-described curing agent and phosphorus-based curing accelerator are a sodium ion-free material (detection limit: less than 1 ppm). With respect to each of the obtained cured products, a 0.5% heat weight decrease temperature was tested as the evaluation of heat resistance in the following method, and the results are shown in Table 2.

[0132]

<Heat resistance: 0.5% heat weight decrease temperature (°C)>

After shaving off 100 mg of the cured product, a 10 mg portion was weighed therefrom and aliquoted to prepare a sample. This sample was subjected to thermal analysis (temperature rise rate: 5°C/min, measurement temperature range: 30°C to 350°C, air: flow rate, 200 mL/min) by using a thermal analyzer (TG/DTA, EXSTAR 7200, manufactured by Seiko Instruments Inc.). A temperature at which the weight of the cured product was reduced by 0.5% was measured and defined as a 0.5% heat weight decrease temperature. It is evaluated such that the higher the 0.5% heat weight decrease temperature, the more excellent the heat resistance is.

[0133]

Table 2

				Example 1	Example 2	Example 3	Example 4	Example 5	Comparative Example 1
Epoxy resin composition blend	Epoxy resin *1	1 (12)	parts	100					
		2 (6)	parts		100		100		
		3 (2)	parts			100		100	
		4 (<1)	parts						100
	Curing agent		parts	56	61	61	56	56	56
	Phosphorus-based curing accelerator		parts	1	1	1	1	1	1
Sodium ion content in composition			ppm	7.6	3.7	1.2	3.8	1.2	<0.6
P/Na molar ratio *2				73	146	439	146	439	879 or more
0.5% heat weight decrease temperature			°C	310	314	313	314	312	308

*1: The numerical value in the parenthesis expresses the sodium ion content (ppm)

*2: A proportion of the phosphorus atom derived from the phosphorus-based curing accelerator to the sodium ion in the epoxy resin composition

Table 3

		Comparative Example 2	Comparative Example 3	Comparative Example 4
Sodium compound added		Sodium oxide	Sodium dihydrogen pyrophosphate	Tetrasodium pyrophosphate
Addition amount of sodium compound*	ppm	7.6	7.6	7.6
Sodium ion content in epoxy resin composition**	ppm	<0.6	<0.6	<0.6
0.5% heat weight decrease temperature	°C	307	307	307

*: Addition amount of the sodium compound to the epoxy resin composition

**: Sodium ion content in the epoxy resin composition as measured by the present measurement method