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**THIS SHEET HAS BEEN
REPLACED**

Sawing suspension and method for cutting wafers from a crystal

5 The invention relates to a sawing suspension which is composed of an essentially nonaqueous liquid in which hard-material particles are dispersed. The sawing suspension is used in conjunction with a wire saw for cutting wafers from a crystal of brittle and hard material.

10 Wire saws are used, for example, in order to divide silicon crystals into thin wafers. A sawing suspension, referred to as slurry, which is transported from the saw wires to the crystal is used in this process as an agent with abrasive action. The sawing suspension
15 is composed of hard-material particles which are dispersed in a liquid. Sawing suspensions with an oil base and with an aqueous base are already known.

From EP-686 684 A1 it emerges that it is disadvantageous to use an oil as liquid for the sawing
20 suspension. The reason for this is, in particular, that the cleaning of oil-contaminated parts of the wire saw and of the wafers is very expensive. A sawing suspension which has an aqueous base and which should contain water-soluble polymers is therefore proposed.

25 According to JP-4218594, if an aqueous sawing suspension is used which contains certain glycols and thickening agents, the extent of the superficial damage to the wafers caused by the cutting operation is reduced.

30 US-4,853,140 describes how the choice of an aqueous cooling lubricant favorably influences the shape (geometry) of silicon wafers if the silicon wafers are cut from a crystal with a sawblade using a cooling lubricant.

35 If a wire saw is used as sawing tool, care has also to be taken that the cut wafers have as flat lateral surfaces as possible, which surfaces should, in addition, also lie parallel to one another. Deviations from this ideal shape are typically quantified by measuring the thickness variation (TTV value) and the sag (warp value)

of a wafer.

The present invention is based on the insight that, if known sawing suspensions are used,

- wafers are frequently obtained whose geometry is
5 unsatisfactory,

- crusts form from hardened material and, consequently, contaminated wafers and wire saw parts can be cleaned only with difficulty,

- the geometry of the wafers obtained sometimes
10 deteriorates after repeated use of a sawing suspension.

The object was therefore to develop a sawing suspension during the use of which such disadvantageous phenomena do not occur.

The invention relates to a sawing suspension
15 which is composed of an essentially nonaqueous liquid in which hard-material substances are dispersed, and wherein the nonaqueous liquid is selected from a group of compounds which comprises low-molecular-weight polyglycols and any desired mixtures of said compounds.

20 The invention also relates to a method in which the sawing suspension is used in conjunction with a wire saw for cutting wafers from a crystal of brittle and hard material.

The sawing suspension is suitable, in particular,
25 for cutting wafers having large diameters of at least 150 mm. With regard to the geometry of the cut wafers, when the sawing suspension is used, a result is achieved which is at least equivalent to the result which is achieved when sawing suspensions based on oil are used.
30 Compared with aqueous sawing suspensions, the proposed sawing suspension permits longer periods of use. The crust formation is considerably reduced. Residues of the sawing suspension can be removed with water without special effort. Furthermore, the sawing suspension is
35 notable for good environmental compatibility since the proposed liquid components are not toxic and are biodegradable.

It has emerged that aqueous sawing suspensions

are suitable for use only over comparatively short periods of time because they rapidly lose water during their use and hard-material particles settle. When sawing from silicon crystals, this water loss is accelerated because chipped silicon splits water into hydrogen and oxygen with the development of heat. As a consequence, silicon dioxide, which incrusts hard-material particles settling with it, is also formed. In addition, troublesome foam formation sets in as a result of the gas formation. These circumstances ultimately have the effect that the geometry of cut wafers no longer meets the requirements even after a comparatively short period of use of the aqueous sawing suspension.

The absence of water is therefore particularly important for a fairly long, successful use of the proposed sawing suspension. However, a small amount of up to 5% by weight of water, relative to the weight of the sawing suspension, can be tolerated, for example, if the presence of water is attributable to the hygroscopic nature of the liquid used to prepare the sawing suspension. A nonaqueous liquid is used which is selected from a group of compounds which comprises low-molecular-weight polyglycols and any desired mixtures of said compounds, the viscosity of the liquid preferably being 50 to 800 mPa·s at 20°C. The preferred molecular weight of the compounds is in the range from 75 to 150. Preferred are propylene glycol, dipropylene glycol, triethylene glycol and low-molecular-weight polyethylene glycols and mixtures of the said compounds. Particularly preferred is dipropylene glycol.

To prepare the sawing suspension, the hard-material particles are dispersed in the liquid, the hard materials mentioned in EP-686 684 A1 preferably being used. A particularly preferred hard material is silicon carbide.

The sawing suspension may be replaced after a certain number of sawing operations. It is also possible to renew initially only a part of the sawing suspension

at regular intervals.

It is furthermore preferred to work up a spent sawing suspension and to remove the hard materials from the liquid. The hard materials may optionally be reused.

- 5 In disposing of the liquid, its biodegradability is preferably utilized.

Patent Claims:

1. A sawing suspension which is composed of an essentially nonaqueous liquid in which hard-material particles are dispersed, wherein the nonaqueous liquid is
5 selected from a group of compounds which comprises low-molecular-weight polyglycols and any desired mixtures of said compounds.
2. The sawing suspension as claimed in claim 1 wherein the nonaqueous liquid is selected from a group of
10 compounds which comprises propylene glycol, dipropylene glycol, triethylene glycol and low-molecular-weight polyethylene glycols and mixtures of the said compounds.
3. The sawing suspension as claimed in claim 1 or 2, wherein the nonaqueous liquid has a viscosity of 50 to
15 800 mPa·s at 20°C.
4. A method for cutting wafers from a crystal of brittle and hard material using a wire saw and a sawing suspension which is composed of an essentially nonaqueous liquid in which hard-material particles are dispersed,
20 wherein the nonaqueous liquid is selected from a group of compounds which comprises low-molecular-weight polyglycols and any desired mixtures of said compounds.
5. The method as claimed in claim 4, wherein the nonaqueous liquid is selected from a group of compounds
25 which comprises propylene glycol, dipropylene glycol, triethylene glycol and low-molecular-weight polyethylene glycols and mixtures of the said compounds.



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Abstract:

The invention relates to a sawing suspension which is composed of an essentially nonaqueous liquid in which hard-material particles are dispersed. The liquid is selected from a group of compounds which comprises low-molecular-weight polyglycols and any desired mixtures of said compounds. The sawing suspension is used in conjunction with a wire saw for cutting wafers from a crystal of brittle and hard material.

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10 FEB 1998

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