sufficient thickness. One known coating fluid for impurity diffusion is the coating source described in JP-B S62-027529, for example.

Citation List

Patent Document 1: JP-B S62-027529

DISCLOSURE OF INVENTION

The coating source described in Patent Document 1, however, has the problem that when the coating source is used to form a p-type diffusion layer in a silicon substrate having a texture structure, the layer becomes thin on peaks of the texture, resulting in a non-uniform boron diffusion concentration. Since the substrate outer circumferential region experiences a higher rotational speed during spin coating than the substrate center region, the coating becomes thinner in the substrate outer circumferential region. The resultant shortage of the impurity source leads to an increase of sheet resistance.

An object of the ~~invention~~present disclosure is to provide a coating fluid for boron diffusion which can form a uniform p-type diffusion layer in a substrate; a method of fabricating a semiconductor device, typically solar cell, using the coating fluid; and a semiconductor device, typically solar cell, fabricated thereby.

The inventors have found that a coating fluid having a modified composition can form a coating having a sufficient impurity content and a sufficient thickness on a substrate surface through spin coating step; and the addition of silica and alumina precursor allows for uniform boron diffusion.

The ~~invention~~present disclosure provides a boron diffusion coating fluid, a method of fabricating a semiconductor device, and a semiconductor device, as defined below.

[1] A coating fluid used to diffuse boron into a silicon substrate to form a p-type diffusion layer, comprising at least a boron compound, an organic binder, a silicon compound, an alumina precursor, and water and/or an organic solvent.

[2] The coating fluid of [1] wherein the boron compound is present in an amount of up to 4% by weight of the coating fluid.

[3] The coating fluid of [1] or [2] wherein the organic binder is polyvinyl alcohol and present in an amount of up to 4% by weight of the coating fluid.

[4] The coating fluid of [1] to [3] wherein the silicon compound is silica and present in an amount of up to 5% by weight of the coating fluid.

[5] The coating fluid of [1] to [4] wherein the alumina precursor is a compound capable of forming alumina upon heat treatment and present in an amount of up to 8% by weight of the coating fluid.

[6] The coating fluid of [1] to [5], having a viscosity of 80 to 140 mPa-s at 25°C.

[7] A method of fabricating a semiconductor device using the coating fluid of any one of [1] to [6].

[8] The method of [7] wherein the semiconductor device is a solar cell.

[9] The method of [8], comprising the steps of providing a n-type silicon substrate with a texture, applying the coating fluid of any one of [1] to [6] to one surface of the silicon substrate, causing a p-type diffusion layer to form, forming a n-type diffusion layer on the other surface of the silicon substrate, forming an antireflective coating on each of the diffusion layers, and forming electrodes.

[10] A semiconductor device which is fabricated by the method of [7].

[11] A solar cell which is fabricated by the method of [8] or [9].

In an aspect, there is provided a coating fluid used to diffuse boron into a silicon substrate to form a p-type diffusion layer, comprising

0.5 to 4% by weight of a boron compound,

0.5 to 4% by weight of an organic binder,

0.5 to 5% by weight of a silicon compound,

0.5 to 8% by weight of an alumina precursor which is a compound capable of forming an alumina film upon heat treatment for boron diffusion, and

77 to 93% by weight of water and/or an organic solvent.

In another aspect, there is provided a method of fabricating a semiconductor device, comprising the steps of:

applying the coating fluid as defined above to a surface of a semiconductor substrate as a coating, and

heat treating the coating to form a boron doped p-type diffusion layer.

Since the boron diffusion coating fluid is formulated so as to contain an organic binder and silica and to be amenable to a spin coating step, a coating having a sufficient impurity content can be uniformly formed on a substrate surface by spin coating step. Even when the substrate used has a texture, typically a pattern of pyramids on its surface as often found in the solar cell fabrication process, a p-type diffusion layer having in-plane uniformity can be formed.