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METHOD OF MANUFACTURING SURFACE WAVE ELEMENT

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a method of manufacturing a surface wave element with a nitride film or oxide film being formed on an aluminum (Al) electrode film coated on a surface wave element substrate. A surface wave element is used for an electronic apparatus such as filter, resonator or the like.

Description of the Related Art

There are problems which arise with conventional hermetic type surface wave elements in that 1) a poor insulating resistance (IR) will result when using metal powders due to the plating formed thereby peeling off a back surface of a metallic cap housing a surface wave element; 2) a poor insulating resistance (IR) will occur from flying metallic particles when welding a metallic cap to a base; and 3) an Al-IDT (Interdigital Transducer) electrode corrodes away during dicing, particularly, if its substrate is made of $LiTaO_3$ or $LiNbO_3$.

The solutions conventionally taken in connection with the above-mentioned problems are to apply a resin onto the back surface of the metallic cap for the prevention of peeling of the metal powders in terms of problem 1); to form a passivation film, made of SiO_2 or the like, on the surface wave element in terms of problem 2); and to mix NO_3 or the like into pure water during the dicing of the substrate for the prevention corrosion of the IDT electrode in terms of problem 3).

Such conventional attempts are disadvantageous in terms of cost, because the countermeasures against the problems 1), 2), and 3) respectively require resin-applying equipment and processes, SiO_2 passivation film-forming equipment and processes, and NO_3-mixing equipment and processes.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a manufacturing method of a surface wave element which is capable of preventing the corrosion of the

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Al-IDT electrode during chip dicing as well as preventing poor insulating resistance without the need for the resin-applying processes to the metallic cap back surface, passivation film-forming processes or NO_3-mixing processes.

To accomplish this object, a method of manufacturing a surface wave element according to this invention comprises the steps of forming an aluminum electrode film on a surface wave element substrate within a belljar; introducing one of an N_2 gas and an O_2 gas into the belljar; and forming one of a nitride film and an oxide film on the formed aluminum electrode film with one of the N_2 gas and O_2 gas introduced.

That is, according to this invention, after the formation of an Al electrode film effected on a surface wave element substrate, an N_2 or O_2 gas is introduced into a belljar so as to produce an insulating film such as a nitride film (aluminum nitride film) or oxide film (aluminum oxide film) on the Al electrode film. Further, plural IDT electrodes are made with the insulating film-added Al electrode film and the surface wave element substrate is diced to manufacture a surface wave element. At this time, the insulating film serves as a protective film to prevent the IDT electrodes from being subjected to corrosion. In addition, the protective film can eliminate the adverse influences of the metallic particles developed during peel-off of the plating on the metallic cap back surface and the welding of the metallic cap to the base, thus reducing the insulating resistance loss.

The above and other objects, features, and advantages of the invention will become more apparent from the following description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic illustration of a sputtering apparatus used for a manufacturing method of a surface wave element according to an embodiment of this invention;

Fig. 2 is a perspective view showing a surface wave element substrate having plural IDT electrodes made on an Al electrode film with an insulating film formed in accordance with the Fig. 1 manner; and

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Fig. 3 is a exploded perspective view of electronic apparatus including a metallic cap housing a surface wave element's final product.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention will be described hereinbelow with reference to the drawings, Fig. 1 of which shows a sputtering apparatus for use in a manufacturing method of a surface wave element according to the embodiment of this invention.

The sputtering apparatus shown in Fig. 1 has the same configuration as a conventional apparatus. In Fig. 1, within a belljar 1 there are set a surface wave element substrate 2 made of $LiTaO_3$ or $LiNbO_3$ and a target 3 made of aluminum (Al). In an atmosphere of argon (Ar) under a given vacuum pressure, an Al electrode film is formed on the surface wave element substrate 2. Thereafter, an N_2 gas is introduced thereinto through a gas inlet 4 so that a film formation process is continuously performed to additionally form a nitride film (aluminum nitride film) on a surface of the Al electrode film. Here, although in this embodiment the Al electrode film is formed on the surface wave element substrate 2 and coated with the nitride film (aluminum nitride film) by the introduction of the N_2 gas, it is also appropriate that an O_2 gas be introduced in place of the N_2 gas so that an oxide film (aluminum oxide film) is formed on a surface of the Al electrode film. In either case, the process is continuous until the iflm is 0.2 μm - 1.5 μm thick.

With the Al electrode film having thereon the nitride film (aluminum nitride film) or oxide film (aluminum oxide film) serving as an insulating film, plural IDT electrodes 5 are made in accordance with the photolithography technique as illustrated in Fig. 2. Following this, the surface wave element substrate 2 which has the formed IDT electrodes 5 is diced along dotted lines in Fig. 2, thus producing surface wave elements. It has been confirmed that a wire bonding could satisfactorily be made for the insulating-film-coated Al-IDT electrodes 5.

Fig. 3 shows an electronic apparatus including a metallic cap housing a surface wave element's final product. A surface wave element's final product 2a is placed on

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a base 6. A wire bonding is made for the insulating-film-coated Al-IDT electrode 5. A metallic cap 7 is welded to the base 6.

According to this invention, in addition to the formation of an Al electrode film 5 on a surface wave element substrate 2, an N_2 or O_2 gas is introduced into a belljar so as to produce an insulating film such as a nitride film (aluminum nitride film) or oxide film (aluminum oxide film) on the Al electrode film 5 and, therefore, when IDT electrodes are made in the Al electrode film 5, the insulating film serves as a protective film to prevent the Al-IDT electrodes from being subjected to corrosion during dicing to produce a surface wave element. Moreover, the protective film can eliminate the adverse influences of metallic particles developed due to the peeling-off of the plating on the back surface of a metallic cap and the welding of the metallic cap to a base, thus reducing the insulating resistance loss. Moreover, the manufacturing method according to this invention does not require the SiO_2 film formation process and resin-applying process for the metallic cap back surface which are needed in the prior art, thereby reducing a manufacturing cost.

It should be understood that the foregoing relates to only a preferred embodiment of the invention, and that it is intended to cover all changes and modifications of the embodiment of the invention herein used for the purpose of the disclosure, which do not constitute departures from the spirit and scope of the invention.

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WHAT IS CLAIMED IS:

1. A method of manufacturing a surface wave element, comprising the steps of:

forming an aluminum electrode film on a surface wave element substrate within a belljar; and

introducing one of an N_2 gas and an O_2 gas into said belljar, thereby forming one of a nitride film and an oxide film on the formed aluminum electrode film with one of said N_2 gas and said O_2 gas.

2. A method of manufacturing a surface wave element in accordance with claim 1, further comprising the step of forming electrodes from aluminum electrode film using a photolithography technique.

3. A method of manufacturing a surface wave element in accordance with claim 1, further comprising the step of dicing said surface wave element substrate between said electrodes.