on a substrate, and molding a lens on the substrate using a mold.

Summary of Invention

In the wafer level lens, both a substrate and a lens are constituted of transparent materials allowing transmission of light, and light can penetrate any part thereof. Owing to this constitution, if a wafer level lens is diced and placed on an imaging device to give an imaging unit and when light transmission and reflection occur at a region other than the lens surface of the lens, there is a fear of tendency of defects in optical performances such as ghosts and flares in taking an image. For preventing such defects, there is for example envisaged a procedure of separately attaching a light shielding member to a region other than the lens of the wafer level lens.

Originally, the wafer level lens has a big profit of suppressing production cost since a plurality of lenses are simultaneously molded on a substrate, and the substrate is diced and connected to a semiconductor substrate carrying thereon an imaging device, and the like. However, if a light shielding member is separately attached, an increase in the production cost corresponding to this process is inevitable.

Embodiments of t~~T~~he present invention provides a wafer level lens with which a sufficient light shielding property is obtained, generation of defects such as ghosts, flares and the like due to a reflected light can be prevented, and an increase in the production cost can be suppressed; a production method of a wafer level lens, and an imaging unit.

According to a first aspect of t~~T~~he present invention, there is provides~~d~~ a wafer level lens having at least one lens module having a substrate and a plurality of lenses formed on said substrate, in which the wafer level lens has a black resist layer formed on the surface of said lens module or on the surface of said substrate, and said black resist layer is formed with a pattern having an opening at a part intersecting the optical axis of said lens.

In this wafer level lens, light transmission at a region other than the lens surface of the lens can be prevented by the black resist layer patterned on at least one of the surface of the lens module and the surface of the substrate. Because of this constitution, generation of defects such as ghosts and flares in taking an image can be prevented, when applied to an imaging module equipped with an imaging device.

Since the black resist layer is patterned on the surface of the lens module or the substrate, there is no necessity to attach another light shielding member and the like to the wafer level lens and an increase in the production cost can be suppressed.

According to a second aspect of tThe present invention, there is providesd a method of producing a wafer level lens having at least one lens module having a substrate and a plurality of lenses formed on said substrate, in which before formation of said lenses on said substrate, a black resist layer is coated on the surface of the substrate, said coated black resist layer is formed with a pattern having an opening at a part intersecting the optical axis of said lens, then, said lens is integrally molded on said substrate.

In this wafer level lens, the black resist layer having a light shielding function is first patterned on the surface of the substrate. In this case, the black resist layer can be formed with a pattern having an opening at a part intersecting the optical axis of the lens, then, a lens can be molded at a region including the opening of the black resist layer. Thus, the black resist layer becomes substantially a lens optical diaphragm.

According to this method, since also the black resist layer can be fabricated together with the lens module in the procedure of producing the wafer level lens, there is no necessity of carrying out a procedure of attaching another light shielding member and the like to the wafer level lens and an increase in the production cost can be suppressed.

The wafer level lens obtained by this method is capable of shielding light penetrating a part other than the lens since the black resist layer has a light shielding function. Accordingly, generation of defects such as ghosts and flares in taking an image can be prevented, when applied to an imaging module equipped with an imaging device.

According to a third aspect of tThe present invention, there is providesd a method of producing a wafer level lens having at least one lens module having a substrate and a plurality of lenses formed on said substrate, in which said lens is molded on said substrate, a black resist layer is coated on the lens surface of said lens and on the surface of said substrate, and said black resist layer is formed with a pattern having an opening at a part intersecting the optical axis of said lens.

According to the procedure of this production method of a wafer level lens, the lens is first molded on the surface of the substrate, then, the black resist layer is patterned on a region excluding the lens surface of the molded lens. Thus, since the black resist layer can be fabricated together in a process of producing the wafer level lens, there is no necessity of carrying out a process of attaching another light shielding member and the like to the produced wafer level lens and an increase in the production cost can be suppressed.

The wafer level lens obtained by this method is capable of shielding light penetrating a part other than the lens by the black resist layer. Accordingly, generation of defects such as ghosts and flares in taking an image can be prevented, when applied to an imaging module equipped with an imaging device.

According to a fourth aspect of tThe present invention, there is providesd a wafer level lens having at least one lens module having a substrate and a plurality of lenses formed on said substrate, in which the wafer level lens has a light shielding layer formed on an at least partial region of the light incidence side outermost surface of said lens module and a low reflective light shielding layer formed with a pattern having an opening at a part intersecting the optical axis of said lens, on the surface of said lens module or on the surface of said substrate other than said light incidence side outermost surface, and said light shielding layer has lower transmittance for a visible light and higher reflection rate than said low reflective light shielding layer.

According to a fifth aspect of the present invention, there is provided an imaging unit having lens modules obtained by separating said substrate of the above lens modules so that each module contains said lens, an imaging device, and a sensor substrate on which said imaging device is disposed.

In a usual glass wafer, owing to reflection at the surface and reflection of a transmitted light in the glass wafer, reflection of 5 to 10% occurs corresponding to about 2 times of the surface reflection. In contrast, this wafer level lens has a light shielding layer and a low reflective light shielding layer. The light shielding layer has a function of preventing transmission of a light in a substrate, by reflecting a light incoming from the outside of the wafer level lens. When a plurality of substrates are disposed, a light incoming from the top substrate surface is reflected by the light shielding layer at a region other than the lens, and it is possible to prevent the light penetrated through a region other than the lens from penetrating between the substrates and to the sensor substrate side.

By providing the low reflective light shielding layer, transmission of a light at a region other than the lens surface of the lens can be prevented.

By providing both the light shielding layer and the low reflective light shielding layer, a light penetrating a part other than the lens can be reflected by the light shielding layer, and even if a light penetrates into the substrate without reflection by the light shielding layer, the light can be shielded by the low reflective light shielding layer. Accordingly, generation of light transmission and reflection at a region other than the lens surface of the lens can be prevented, and defects in optical performances such as ghosts and flares in taking an image can be suppressed.

Further, since the light shielding layer and the low reflective light shielding layer are patterned on the surface of the substrate, there is no necessity to attach another light shielding member and the like to the wafer level lens and an increase in the production cost can be suppressed.

Embodiments of t~~T~~he present invention are~~is~~ capable of providing a wafer level lens with which a sufficient light shielding property is obtained, generation of defects such as ghosts, flares and the like due to a reflected light can be prevented, and an increase in the production cost can be