July 2022

Opto-Mechanical Failure Detection for Transparent Materials

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ABSTRACT

This disclosure describes techniques for in-situ detection of failures in optical components. Conductive clear coatings, e.g., Indium Tin Oxide (ITO) coatings are applied to optically transparent components. Measurements of resistance or capacitance across the coated layers are utilized for the detection of component failure(s) and/or surface contamination on optical surfaces. ITO is optically transparent and electrically conductive, thereby enabling detection of failures without affecting normal functionality of an optical device. For example, ITO is applied as a trace on a surface of the optical component to form an ITO trace network. Component breakage is detected based on a conductance measurement across the ITO trace network. In some cases, the ITO trace network and conductance measurement system can be applied to all optical surfaces on the component, thereby enabling detection of failures on any of the surfaces of the optical component.

KEYWORDS

- Conductive coating
- Transparent coating
- Clear coating
- Indium Tin Oxide (ITO)
- Augmented Reality (AR)
- Wearable device
- Optical component
- Waveguide
- Heads-up display (HUD)
- Surface contamination
- Eyepiece
- Optical device
- Trace network

BACKGROUND

Wearable headsets such as augmented reality (AR) or virtual reality (VR) heads-up displays (HUDs) redirect images from a projector to the user's eye through a waveguide optical component placed in front of or within the ophthalmic lenses of the headset. The waveguide component must both propagate a projected image from elsewhere in the headset assembly and, at the same time, maintain transparency for the user to see the world. Its integrity is paramount to safely directing a controlled luminance to the user and world. Typically, this component is a relatively thin (hundreds of micrometers to several millimeters) and wide (6cm by 5cm) sheet of glass. Because of its geometry and placement within an ophthalmic lens stack, the component is prone to failure due to cracking or trapped condensation on the waveguide. Since the wearable device utilizes optically transparent components, there can be a functional or safety requirement to detect failure (cracking or surface contamination) of optical components while in operation. Early indication of waveguide failure can improve safety and functionality of the wearable device. Other optical systems can also benefit from early detection of failures in optical components.

DESCRIPTION

This disclosure describes techniques for in-situ detection of failures in optical components and/or devices. The techniques are applicable to any optical system that requires immediate failure detection with little compromise to optical performance. For example, such systems include displays, projectors, low-mid power laser routing, laser ranging, etc. In particular, the described techniques are useful in AR/VR headsets.

Per techniques of this disclosure, conductive clear coatings (layers), e.g., made of Indium Tin Oxide (ITO) or other suitable material, are applied to optically transparent components in an

optical system, such as components included in augmented reality (AR) or virtual reality (VR) devices. Measurements of resistance or capacitance across the coated layers are utilized for the detection of component failure(s) (e.g., a crack) and/or surface contamination on optical surfaces. ITO is optically transparent and electrically conductive, a combination of properties that enables it to be utilized to detect failures without affecting the normal functionality of an optical device such as a wearable headset.

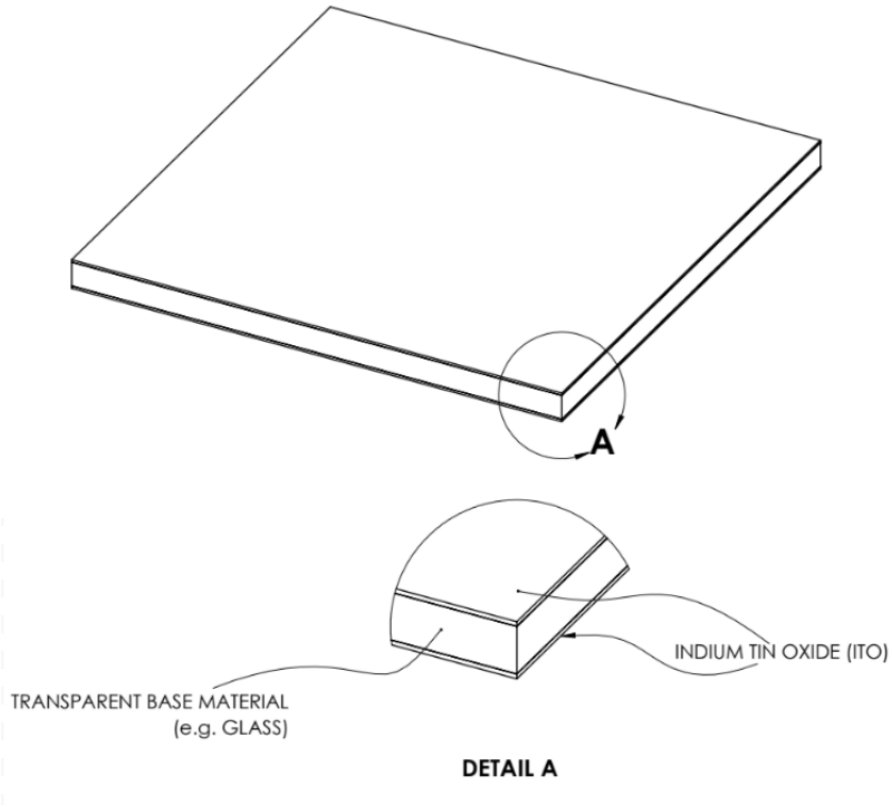

Fig. 1: Example optical component

Fig. 1 depicts an example optical component made of glass. As depicted in Fig. 1, a thin layer of Indium Tin Oxide (ITO) (or other conductive clear coating) is applied to either side of the optical component to be monitored. The optical transparency of the material ensures the primary function of the optical component is unimpeded. Each side is connected to an electrical circuit (system) that is utilized to measure a capacitance across the circuit. A failure (crack,

surface contamination, etc.) of the optical component manifests as a change in the measured capacitance.

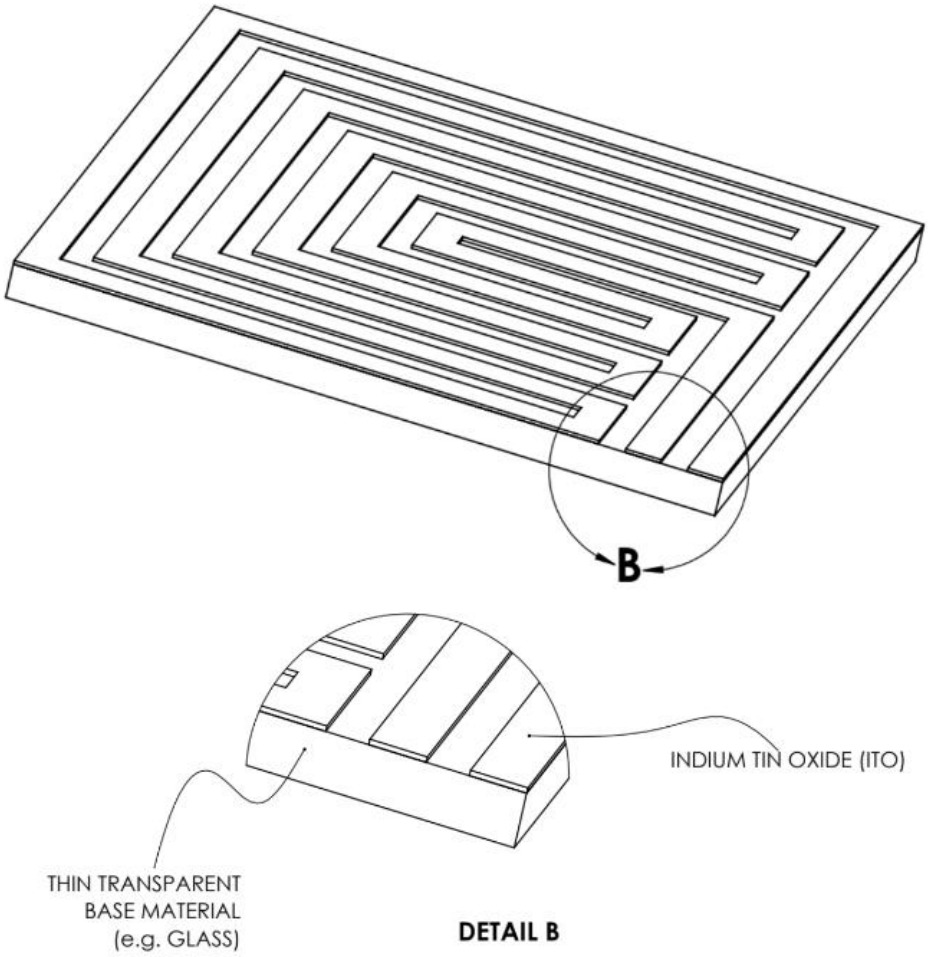

Fig. 2: Example of an ITO coated optical component

Fig. 2 depicts another example of an ITO coated optical component. In this example, the coating is applied as a trace on a surface of the optical component to form an ITO trace network. Component breakage is detected based on a conductance measurement across the ITO trace network. The ITO trace network is designed such that even small breaks in the optical component which damage any portion of the ITO trace network result in a measurement of zero conductance across the ITO trace network.

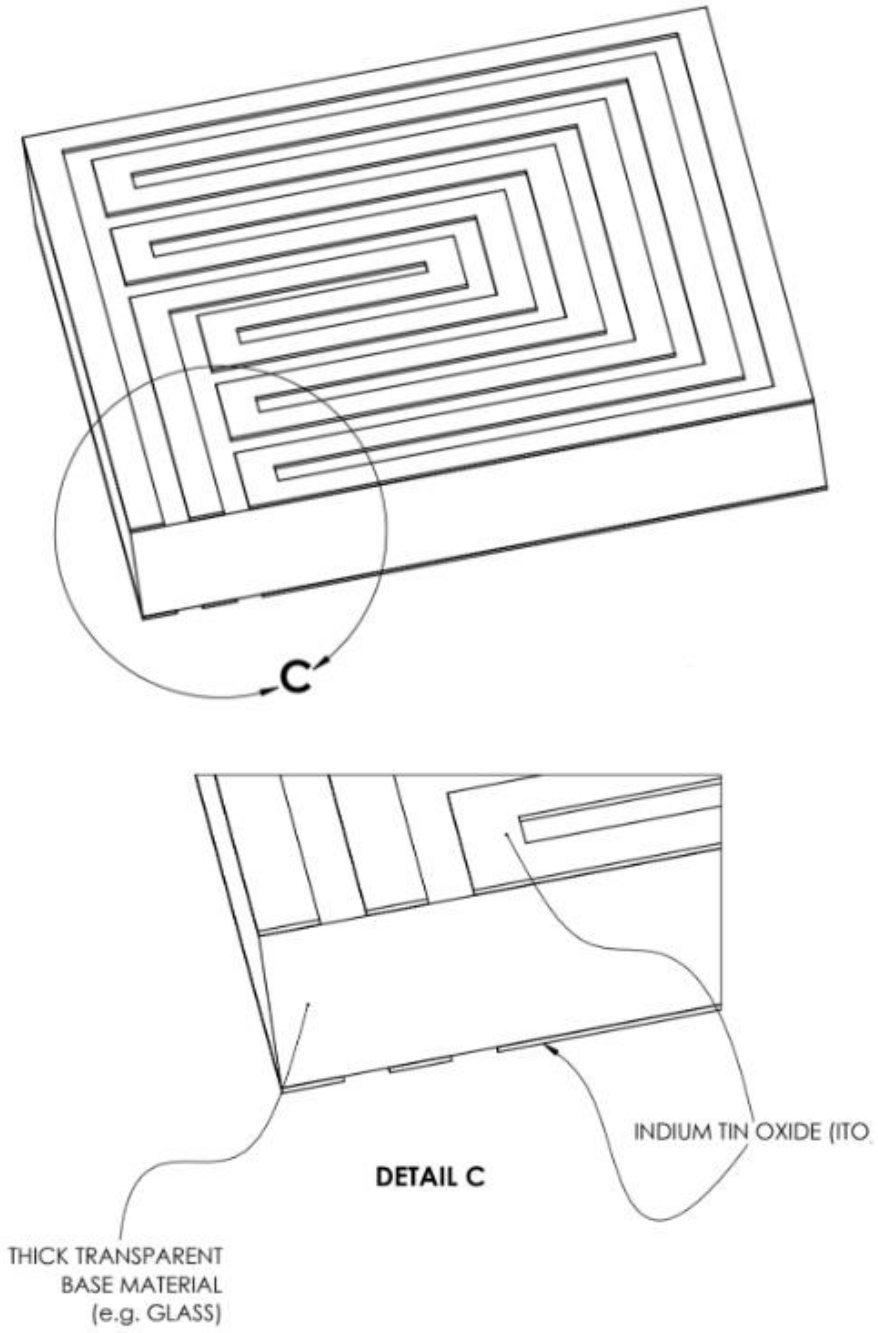

Fig. 3: An ITO trace network is applied to multiple layers of an optical component

Fig. 3 depicts another example of an ITO coated optical component. This can be utilized for device applications where even small scratches and cracks can constitute a failure. In this example, an ITO trace network and conductance measurement system can be applied to all

optical surfaces on the component, thereby enabling detection of failures on any of the surfaces of the optical component.

Techniques of this disclosure offer several advantages for the detection of failures in optical components in devices such as headsets.

- High accuracy of failure signals since measurement of compromised capacitance is highly correlated with a compromised optic (optical component).
- Rapid and immediate failure detection .
- Transparent coating has minimal impact on optical performance of the component.
- Coating application adds relatively low complexity to the manufacturing process since optical components typically undergo multiple coating steps during manufacturing.
- The electrical system is lightweight and suitable for wearable devices.

CONCLUSION

This disclosure describes techniques for in-situ detection of failures in optical components. Conductive clear coatings, e.g., Indium Tin Oxide (ITO) coatings are applied to optically transparent components. Measurements of resistance or capacitance across the coated layers are utilized for the detection of component failure(s) and/or surface contamination on optical surfaces. ITO is optically transparent and electrically conductive, thereby enabling detection of failures without affecting normal functionality of an optical device. For example, ITO is applied as a trace on a surface of the optical component to form an ITO trace network. Component breakage is detected based on a conductance measurement across the ITO trace network. In some cases, the ITO trace network and conductance measurement system can be applied to all optical surfaces on the component, thereby enabling detection of failures on any of the surfaces of the optical component.