June 2023

Ultraviolet (UV) Bonding Process

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ABSTRACT

This disclosure describes techniques to enable utilization of UV-activated bonding in a variety of devices and scenarios. The techniques can be utilized even in geometries where line of sight between an external UV radiation source and a bonding site is unavailable. Photoluminescent materials are added to the photoresist, UV-activated adhesive, stamp, etc., and are activated by utilizing incident X-ray beams. The specific photoluminescent material is selected based on the wavelength required by the curing process. The photoluminescent materials absorb the X-ray radiation and emit UV radiation that in turn activates the curing process. X-ray radiation can pass through a variety of materials and do not require a direct line of sight from their source to the bonding site in order to activate the photoluminescent material. Photoluminescent material is mixed with the UV-activated adhesive prior to its application at the bonding sites or is applied directly.

KEYWORDS

- Photoresist
- Adhesive curing
- X-ray
- Ultraviolet (UV) Glue
- Photoluminescence
- Nanoimprint Lithography
- Line of sight
- Light activation
- UV curable adhesive
- Photopolymerization

BACKGROUND

Photoresists and ultraviolet (UV) activated adhesives are commonly utilized to bond (attach) components to substrates during manufacturing processes. For example, a UV-activated adhesive may be utilized to attach a plastic optical component to a supporting structure. The UV-

activated adhesive typically includes a photoinitiator that is activated by UV radiation. The curing process of a UV-activated adhesive or photoresist requires a line of sight from a UV light source to the location of the area where the curing and/or bonding is to take place (e.g., location on the substrate where the component is to be attached). The presence of even a transparent material such as glass in the path of the UV radiation can cause some of the UV radiation to be absorbed, potentially leading to a failure of curing or to under-curing.

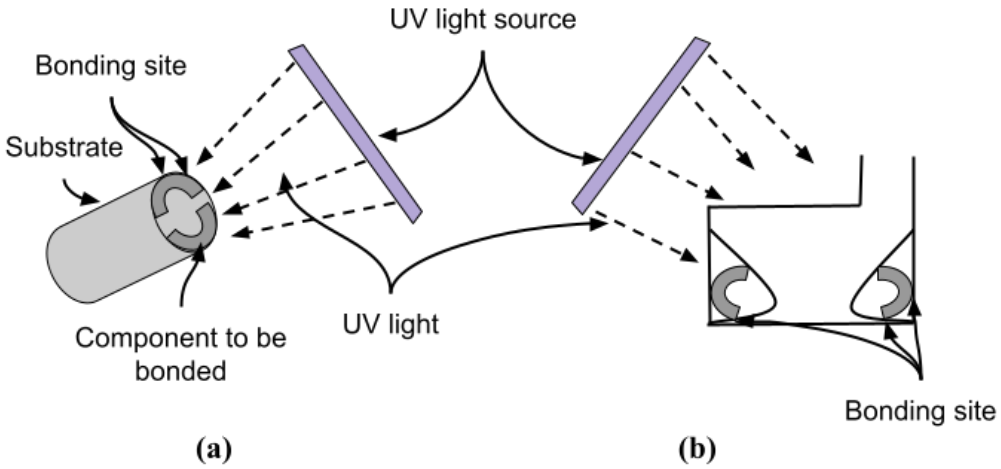

Fig. 1: Ultraviolet activated bonding

Fig. 1(a) depicts an example bonding of a component to a substrate using UV adhesives. As depicted in Fig. 1(a), the component to be bonded is placed on the substrate at the site of bonding. The UV-activated adhesive (not shown) is applied at the bonding site. When UV radiation of a specified wavelength (based on the particular UV adhesive) from a UV light source is incident on the bonding site, the UV adhesive is activated, leading to polymerization and curing. After the completion of the curing process, the component is bonded to the substrate.

Fig. 1(b) depicts an example scenario where there is insufficient or no line of sight available between a UV light source and the bonding site. This can occur due to the geometry of

a particular device, as well as due to the presence of intermediate surfaces. In such a scenario, a UV-activated bonding process, which is relatively efficient and cost-effective, cannot be utilized.

DESCRIPTION

This disclosure describes techniques to enable utilization of UV-activated bonding in a variety of devices and scenarios. The techniques can be used even in geometries where a line of sight between an external UV radiation source and a bonding site is unavailable. Per techniques of this disclosure, intermediate photoluminescent materials are added to the photoresist, UV activated adhesive, stamp, etc., which are activated in-situ by utilizing incident X-ray beams.

The intermediate photoluminescent materials absorb X-ray radiation and emit UV radiation that in turn activates the UV activated adhesive, photoresist, stamp, etc. X-ray radiation can pass through a variety of materials and does not require a direct line of sight from the source to the bonding site in order to activate the photoluminescent material.

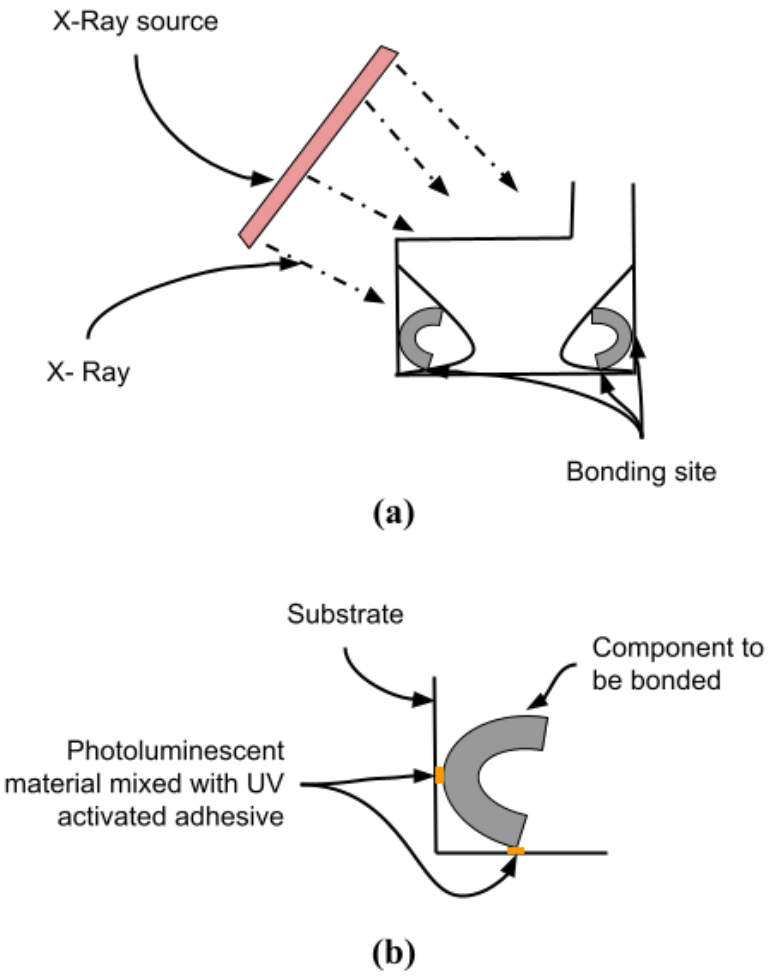

Fig. 2: Photoluminescent materials generate UV radiation based on incident X-rays

Fig. 2 depicts an example of activation of a photoluminescent material by X-rays in a bonding process, per techniques of this disclosure. As depicted in Fig. 2(a), the substrate and the component to be bonded are irradiated with X-rays from an X-ray source. The X-ray radiation can pass through intermediate surfaces and does not require line of sight. Photoluminescent material is mixed with the UV-activated adhesive prior to application at the bonding sites. The specific photoluminescent material is selected based on the wavelength necessary for the curing process, e.g., activation wavelengths of the UV activated adhesive, photoresist, stamp, etc.

X-rays can travel through surfaces and do not require a line of sight between the X-ray source and the bonding sites. In some implementations, the photoluminescent material is applied to one or more bonding surfaces. Techniques of this disclosure can enable batch curing of devices on a larger scale since direct exposure of every bonding (cure) site is not needed.

CONCLUSION

This disclosure describes techniques to enable utilization of UV-activated bonding in a variety of devices and scenarios. The techniques can be utilized even in geometries where line of sight between an external UV radiation source and a bonding site is unavailable. Photoluminescent materials are added to the photoresist, UV-activated adhesive, stamp, etc., and are activated by utilizing incident X-ray beams. The specific photoluminescent material is selected based on the wavelength required by the curing process. The photoluminescent materials absorb the X-ray radiation and emit UV radiation that in turn activates the curing process. X-ray radiation can pass through a variety of materials and do not require a direct line of sight from their source to the bonding site in order to activate the photoluminescent material. Photoluminescent material is mixed with the UV-activated adhesive prior to its application at the bonding sites or is applied directly.

REFERENCES

1. “Typical Luminescent Materials” available online at https://www.phosphor-technology.com/typical-luminescent-material/ accessed May 16, 2023.