Advances in photorefractive polymer material for dynamic holographic printing

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Advance in photorefractive polymer materials have enabled the realization of a refreshable holographic 3D display using holographic printing technique. We are reviewing the current system limitation and are discussing material research to enable full color, high sensitivity and pulsed operation.

We recently introduce an updatable holographic 3D display based on photorefractive polymer material [1, 2]. The system is based on holographic printing, which is a powerful technique that allows to display information with parallax [3-4]. That technique is not limited to real objects like classical holography, since computer generated information can also be recorded. As well, it is not confined to perspective reproduction since movement or any type of angular multiplexed data can be encoded.

Holographic printing principle is to cover the entire surface of the display with holographic pixels (hogels), each one diffracting the information along a structured cone of light (angular multiplexing). When such a hologram is replayed and the viewer (or scanning probe) moves in front of the display, it intercepts different rays of light, replaying different images according to position. This can be use to render perspective and parallax, reproducing realistic 3D pictures. Applications range from data storage to medical imaging or advertisement [5].

So far, holographic printing was limited to static holograms due to the lack of appropriate dynamic media. Most of the printers use photopolymers or silver halide gelatin which are write once read many types of substrate. We introduced a new photorefractive polymer material with high efficiency, high sensitivity and long persistency time suitable for that application in write many read many type of operation. Our 3D display system has a writing time of two minutes for a reading time up to two hours with the possibility to refresh or change the hologram anytime. In this presentation we will introduce our latest research to overcome the limitations of the present photorefractive polymer to improve speed, image quality, and resolution of the display.

Full color is an important aspect for realistic image reproduction. The material we are currently using have a strong absorption below 520 nm preventing replaying the blue color in a transmission type hologram. New chromophores are investigated in order to shift the absorption peak toward the UV, reducing the blue absorption. Smaller conjugate bound attaching weaker donors and acceptor moieties are reviewed to find the correct balance between absorption and index modulation.

Sensitivity is an essential aspect to reduce the writing time. We are currently recording each hogel for one second with 50 mW/cm² beams. Considering there are 10 hogels/cm for horizontal parallax only, the recording time approaches 2 minutes for a 10 cm² image. Full parallax will require 10x10 hogels/cm² and so 240 minutes for the same surface: more than the hologram persistency time. We are looking to nanoparticle sensitization to improve the efficiency while keeping a long persistency time needed for image display.

Writing each hogel with a single nanosecond pulse will enable much faster speed (depending of the laser repetition rate) and will desensitize the setup to vibration which will be a major improvement. Ultimately, it also has the potential to make holographic 3D television a reality thanks to high repetition rate laser. We will present the most recent advances of our group toward that direction.

References

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