홀로그램 기록을 위한 포토폴리머 균일도 연구

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A study on parameters for uniform polymerization of photo-polymers

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요 약

This paper addresses the analysis of uniformity in photopolymer photopolymerization. Considering the Gaussian distribution characteristics of laser light used as the source, the uniformity was analyzed, and simulations were performed under various spot interval conditions. Experimental results showed that a 0.1 mm interval provided the highest performance, but it required a significant amount of time. In contrast, at a 6.7 mm interval, the uniformity was comparable to that of the 0.1 mm condition, while the replication speed was greatly improved, leading to its identification as the optimal condition.

Ⅰ. 서 론

In the process of hologram fabrication, the technique of inducing polymerization of monomers into photopolymers using a laser light source has become highly significant. In particular, the ability to replicate holograms at high speed while maintaining the quality of the master hologram is crucial. To ensure that the replicated hologram maintains a quality comparable to the master, it is essential to secure uniformity in the irradiated light intensity. This paper analyzes the uniformity of irradiated light intensity in order to achieve both high-speed replication and consistent quality of the generated photopolymer.

Ⅱ. 본론

In photo-polymer fabrication technology, a laser is generally used as the light source. In this case, the profile of the laser light source can be assumed to follow a Gaussian distribution with a mean of 0 and a variance of σ^2 (1). The definition of the Gaussian profile is as follows.

$$\left| A_0 \exp\left\{ -\frac{1}{2}\left(\frac{x^2+y^2}{\sigma^2} \right) \right\} \right|^2 \quad (1)$$

Here, A0 represents the intensity of the light source, and x,y denote the spatial coordinates. In the Gaussian profile, the distribution can be adjusted by varying σ^2. Equation (1).

In order to analyze the light uniformity of the replicated hologram in hologram replication technology, simulations were conducted in this study under the following experimental parameter conditions.

Table 1. Experimental Parameters

Spot 크기	100 mm × 100 mm
가우시안 프로파일에서 σ2	1
광원의 세기	10 mW
픽셀 크기	100 μm
마스터 홀로그램 크기	200 mm × 200 mm
Spot간의 간격	0.1 mm ~ 75.1 mm

Ⅲ. 결론

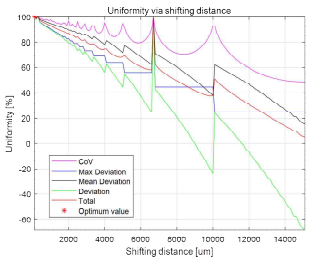

Fig 1. Analysis Results of Light Uniformity for Hologram Replication

As shown in Figure 2, replication with a spot interval of 0.1 mm produced the best results. However, because the spot interval is very narrow, the hologram replication process requires a considerable amount of time. In contrast, when the spot interval was 6.7 mm, the uniformity performance was similar to that of the 0.1 mm condition. Moreover, since the spot interval is 67 times wider, the replication speed is significantly faster. Therefore, under these experimental parameter conditions, a spot interval of 6.7 mm can be considered the optimal condition.