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High density “Lippmann” data storage in thick holographic materials

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Lippmann interference photography is a, more than one century old, colour photographic process [1]. In spite of this oldness, we decided to revisit this photographic process and to evaluate its ability to use it for mass data storage. Lippmann photography indeed shares many features with Denisyuk volume holography used for high density data storage [2]. In this photographic process, a lens images the scene onto a mirror set in contact with a thick photographic plate. The incident beam thus interferes with its reflection and records a small Bragg grating inside the thickness of the sensitive layer. The mirror is then removed and the photographic plate is processed. Illuminating this processed plate with white light reproduces the coloured scene thanks to the Bragg wavelength selectivity. Thus, similarly to holography, the colours are recorded by interferences. Nevertheless, contrary to holography, an additional reference beam is not required.

We are not the first to propose the Lippmann architectures for data storage [3,4]. Nevertheless, all the previous proposals were implemented in a bit oriented approach in which a focused beam records a series of wavelength multiplexed Bragg gratings, the coherence length for each wavelength being larger than twice the material thickness. Stacks of Bragg gratings are juxtaposed by moving the recording beam at other locations. We previously demonstrated that, with such an approach, increasing the material thickness does not improve the storage capacity.

In order to increase the capacity we now propose to implement Lippmann data storage by wavelength multiplexing pages of data at each location [5]. We demonstrate that if the depth of focus of the images is smaller than the material thickness, then noise appears during image readout. It originates from the fact that the reference beam used for reading out is a plane wave, while, during the recording process, the image beam itself acts as the reference. Nevertheless, we show that this noise can be kept at a reasonable level for data pages correctly formatted; typically binary amplitude images with a uniform phase. Data can then be retrieved without ambiguity whatever the material thickness. The wavelength selectivity of these recorded images is then similar to the Bragg selectivity of uniform reflection gratings. We thus anticipate that the capacity of Lippmann storage in thick holographic material should be the same as for conventional wavelength multiplexed holographic materials. First experimental tests will be presented.

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