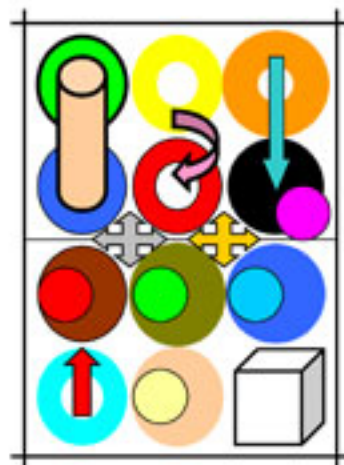


The SilverCross Project

www.silvercrossproject.org



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Full colour holography is the most perfect imaging technology known to science. In the entrance hall to the Centre for Modern Optics (OpTIC, NEWI), there are some unusual and beautiful objects: one a magnificent vase, another a highly-decorated Russian egg. Many visitors to the Centre glance at these objects and then walk past; until it is pointed out to them that they are holograms! These objects are excellent and rare examples of full-colour holograms, and are so realistic that they are difficult to distinguish from the real object.

Developments in other technology areas have prepared the way for many exciting applications for full-colour holograms. However, these new markets are unexploited due to a lack of commercially-available recording material. This limitation is crippling European holographic-based industries, and consequently colour holography is restricted to a handful of laboratories and research centres.

SilverCross aims to solve this problem by developing a new nanoparticle (5-10 nm), high sensitivity (<2 mJ cm⁻²) low light-scattering, panchromatic silver halide emulsion which may be used for high quality imaging recording techniques, including full colour holograms and HOEs.

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NEWI North East Wales Institute of Higher Education
Developing Skills, Enriching Lives

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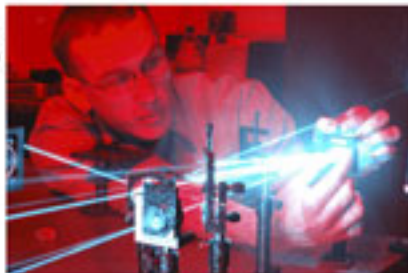


SilverCross: Background

What is a colour hologram?

A hologram is a very high-resolution recording of the interference pattern formed between a wave scattered from an object or scene, and a 'reference' wave. When the hologram is illuminated with a correctly chosen source, an exact copy of the original object wave is reproduced in three dimensions. If the recording and replay are made with white light, and the light-sensitive medium is capable of recording the ultra-fine lines of the interference pattern, then the reproduced 3D image will be in full colour. The observer perceives a perfect image, almost indistinguishable from the original scene.

The whole process relies on having a suitable recording material. In order to accurately reproduce the object wave, the recording material must be able to resolve the highest spatial frequencies of the interference pattern. In order to record blue light, this requires the material to resolve features with a size of around 10 nm or less. It also needs to have high sensitivity across the whole visible spectrum, and enough resolution to cope with several super-imposed holograms (e.g. from red, green and blue lasers).



The potential for colour holography

Currently, holograms are generally regarded as novelty items by the EU general public. Most are familiar with the mass-produced embossed holograms used as a security device on credit cards or bank notes. Some have seen wonderful high-quality artistic holograms. However, few are aware of the numerous practical uses of holograms, for example holographic optical elements (HOEs) are already used from head-up displays in military aircraft to barcode scanners at supermarket checkouts. However, holography is a technology which has only fulfilled a fraction of its potential. Full colour holography would allow many more exciting applications to be realised:

- Reproductions of artifacts in museums and art galleries
- Holographic advertising
- Full colour head-up displays in cars and aircraft
- Energy-saving elements in liquid crystal displays
- Medical 3D imaging applications

The problem: no recording material

There has been surprisingly little improvement in holographic recording materials since the 1960's, and there are no commercially available materials to record high quality colour holograms. There are a number of candidate materials which are currently used to record high resolution holograms including: silver halide emulsions, dichromated gelatin and photopolymers. The best candidate material for this task is photographic silver halide emulsion.



SilverCross: Objectives

Objectives

SilverCross will produce a process suitable for mass-manufacture of super-resolution silver halide emulsion-coated plates capable of making full-colour holographic recordings. In order to achieve this aim, firstly, the necessary silver halide grain size must be attained; secondly, the photo-sensitivity and dynamic range of the material must be increased and the reciprocity failure addressed. Finally the manufacturing processes must be scaled up from the laboratory to mass manufacture. Thus there are three separate areas of activity:

1. Grain preparation

The emulsion work will be based on conventional fine-grain emulsion technology together with novel techniques developed at CLOSP1 and NEW1. These empirical techniques require development in order to give reliable results, and consistently uniform particle size. SilverCross will identify a standard procedure through meticulous targeted iterative experiments to manufacture emulsions with a uniform grain size of 5-10 nm.

2. Emulsion sensitisation

In order to obtain an emulsion that is both panchromatic and isochromatic without a serious reciprocity failure problem, it will be necessary to sensitise the emulsion. This will be achieved using synthetic dyes for spectral sensitisation and other novel techniques to increase the general sensitivity of the tiny silver halide particles. Once an emulsion with the required grain size has been successfully achieved, the optimised sensitisation process will be devised to achieve a panchromatic sensitivity of $<2.0 \text{ mJ cm}^{-2}$.

3. Manufacture

Techniques for attaining plates or film uniformly coated with these emulsions have to date only been achieved on a small scale and with poor quality control. Increasing the output to the levels of volume manufacture will take a significant degree of invention. SilverCross will produce a prototype production rig as a precursor to full commercial manufacture.

The fabrication of these materials on a commercial scale will represent a major advance in the state-of-the-art, and will open up whole new markets for holography in areas including art, cultural heritage, security and displays.

