GLOSSARY OF TERMS

Casting. A method of embossing whereby a film of soft resin is applied to a nickel shim then exposed to ultraviolet light causing the resin to harden by cross linking. The resin film can now be removed and retains a faithful copy of the surface relief image that was present on the shim. This method of transferring an image from a nickel shim onto a plastic film, results in a bright image and causes very little wear to the shim.

Classic hologram A classic hologram is usually made using a 3D object, often a model. A laser beam is split in two and part is diverted onto the object, reflected off it then allowed to combine (or interfere) with the other part of the beam known as the reference beam. The classic hologram is a recording of the interference pattern. A well known example of such an image would be the small dove used by Visa on their credit cards.

Demetallisation. A two stage process in which metal, usually aluminium, is deposited onto the hologram and then selectively removed. The removal is achieved by either first printing an protective resin onto the metallic layer then dissolving away the unprotected metal, or ablating the metal with a laser beam.

Diffraction. A phenomenon whereby light waves are bent as a result of passing through small apertures whose dimensions are comparable to the wavelength of light. Of particular interest are gratings with line spacings close to the wavelength of light because these have the ability to bend light of different wavelengths by different amounts. Hence they produce a prismatic effect of splitting white light into the various colors of the rainbow.

Dot matrix. A surface relief hologram built up from an array of tiny diffractive gratings arranged at certain angles, is called a dot matrix hologram. The ‘dots’ are a point at which two microscopic beams of laser light meet at an angle and produce an interference pattern. In a dot matrix machine, a mechanical arrangement moves this point of light in a matrix pattern relative to a photosensitive plate. According to the final image required, the angle at which each dot is exposed into the matrix is determined by mathematical calculation. It is thus possible to construct fully synthetic images of objects that never existed in real life.

e-beam (Electron Beam Lithography) A method of creating a holographic image is to dispense with the traditional method of creating an interference pattern by interfering two laser beams and ‘write’ the individual interference fringes using a fine beam of electrons in a vacuum chamber. The challenge here is to calculate the exact position of each fringe according to where it would have resulted if an reference beam had interacted with an object beam. If the correct software is available, this method of origination is the most versatile as it is capable of producing the same results as any other origination technique and any combination of them.
It is occasionally possible to use a suitably modified electron microscope as the hardware to carry out this operation.

Embossing (Hard & Soft). Embossing is the process whereby a surface relief hologram on a nickel shim is transferred to a relatively inexpensive plastic film. The shim or shims are mounted onto a cylinder and pressed into a thermoplastic film with heat and pressure. If the film is a tough plastic such as polyester, or is coated with a thin layer of metal to make it reflective, the process is called hard embossing and the lifetime of the embossing shim is relatively short. In such a process, the image may be exhausted from the shim after only a few hundred feet of embossing. For this reason, the plastic film is usually coated with a softer layer which deforms more easily under heat and pressure. This is called soft embossing and many thousands of feet can be produced before the embossing shims need to be replaced.

Eye-mark or registration mark. Where some step in the overall manufacturing process requires a machine to process a single holographic image, an eye mark (or registration mark) is invariably place next to each image. Examples of such processes are e.g where an automated die cutter must cut an individual image and convert it into a label. Another example might be where a roll of registered image holograms on a roll of hot stamping foil must have the discrete images stamped onto something. In each case, the cutting or stamping machine will advance the image until the next registration mark is optically detected and then the image is either cut or stamped. These marks are usually square in shape and consist of a diffraction grating allowing the mark to be detected at a specific angle.

Grating. A grating is a series of parallel lines having a spacing comparable with the wavelength of light. Such an array of lines has the ability to split white light into a rainbow because the different wavelengths are bent, or diffracted, by different amounts. Such gratings were originally produced by using a diamond to rule closely spaced lines onto glass but they are now more often produced by optical interference.

Hologram. The term ‘hologram’ is derived from two Greek words ‘holos’ meaning whole or complete and ‘graphos’meaning an image. The term therefore describes a recorded image which is *complete*, in that it shows the whole volumetric space of the object or image, as opposed to a conventional picture, painting or photograph which displays an object from a single viewpoint. In a conventional two dimensional picture (2D) side to side movements of the viewer relative to the image do not supply any more information about the subject but if ‘The Laughing Cavalier’ had been a hologram, then such a movement would have enabled the viewer to see first one ear and then the other in the manner of viewing a statue.

Hot stamping foil. Hot stamping foil (HSF) is a thin material which is applied to paper or other substrate through the combination of heat and pressure. HSF can be used to support holographic images which can be transferred, using heat and pressure, onto another substrate such as paper or plastic. The layers containing the holographic image are extremely thin, typically 5-6 microns. Therefore they need to be supported on a thicker material such as 19 micron thick polyester. The action of stamping the foil with a heated die causes a ‘release’ layer between the hologram and the polyester support, to melt while simultaneously softening an adhesive ‘size’ coating. These combined effects allow the hologram to leave the polyester support and adhere, irreversibly, to its new location.

HRI, or High Refractive Index. In situations where a transparent hologram is required, e.g, for use as a laminate to cover the variable data of a passport or other ID document, instead of coating the holographic image with a metallic film, a transparent coating is made using a material with High Refractive Index. If transparency is achieved by simply not coating with metal, the image will disappear with handling or when an adhesive is applied because the microscopic rideges and grooves fill with the adhesive or body oils, so that there is no diffraction and no hologram. The HRI materials used in this process are oxides (eg titanium dioxide) or sulphides (eg zinc sulphide).

Kinetic. An adjective whose roots in the Greek word 'kinesis' indicate motion. A holographic image which displays excessive movement of form or color is said to be kinetic. Often, such images are patterns rather than objects. The patterns can be made up of fine lines or graphic elements and appear to scintillate when moved. The Swiss company Landis & Gyr found a particularly effective way of producing such designs and called them 'kinegrams'. The term is now trademarked, owned by the German company Leonard Kurz and used only for high security application such as banknotes, passports and other identity documents.

Multi-channel . A holographic image in which different, usually unrelated images appear at different viewing angles. The most usual, and easiest to make, is for the images to flip from one to another as the hologram is tilted from side to side. The most difficult is for the image to change as the hologram is rotated.

Parallax The phenomenon in an image which allows depth to be judged from the movement of near image elements relative to more distant ones. Traditional embossed holograms only display parallax from side to side but the lack of vertical parallax is rarely noticed.

Rainbow. A rainbow is the visual result of splitting white light into its constituent colors according to wavelength. The order of the colors is red, orange, yellow, green, blue, indigo, violet with red having the longest wavelength and violet the shortest. The natural phenomenon is caused by the prismatic effect of raindrops in the sky but it can also be caused by diffractive gratings with a spatial frequency approaching the wavelength of light.

Recombination. The 'step and repeat' process whereby a single, holographic image is laid out in rows and columns in preparation for shim production. It can either be carried out mechanically or optically. In the mechanical process, the single image is made into a stamper which is impressed at pre-determined intervals, into a plastic sheet. If done optically, the single image is exposed in a predetermined pattern onto a (glass) plate coated with a photoresist.

Reflection hologram. See volume hologram. These are viewed by the reflection of white light. The diffractive planes within the depth of the recording material have a spacing which corresponds only to a single wavelength of light. This wavelength, usually green or yellow, is reflected back and reconstructs the image, the other colors being transmitted and absorbed by a black backing placed behind the hologram.

Shim. A ‘shim’ is a thin plate of metal, usually nickel, which is attached to a cylinder in preparation for the embossing process. The shim is produced by an electro-deposition process whereby the plate with the recombined images is immersed into a galvanic tank and metallic nickel is caused to accumulate on its surface. This metal plate is usually referred to as the ‘master’ or ‘mother’ shim. It is usually used to prepare ‘daughter’ shims which are used for the mechanical embossing process.

Shim line. At some point in the hologram replication process, one or more metal shims need to be mounted around the circumference of a metal cylinder (the embossing cylinder). The point at which the shims join often produces a visible line in the resulting embossed film. This line is most objectionable where the finished result is intended to be a continuous pattern. Those skilled in the art have developed procedures which successfully minimise or even eliminate such optical discontinuities in the final product.

Stereogram. This is a hologram prepared using the sequential images from a piece of movie footage. Each frame of the movie is converted into a vertical slit image and stacked against another slit image of the adjacent frame. The result is a hologram which, when the viewing angle changes side to side (usually), the same image motion as the movie footage is seen as the frames are seen one after another. The technique usually employs around 100 movie frames equivalent to only a few seconds of action.

Surface-relief hologram. A surface relief hologram is one in which all the details of the image are recorded as an interference pattern on the surface of some material. It can be imagined as the ripples on water frozen in time except that the ripples are the interference patterns arising when two laser light beams interfere with each other, and the ripples are tiny, with a frequency close to the wavelength of light. The value of such surface relief holograms is that they can be mass replicated by mechanical transfer from a master image to inexpensive plastic.

Transmission hologram. A transmission hologram is one that can be seen by light passing through the material containing the holographic image. Ironically, all metallized, embossed holograms are transmission holograms but are conveniently seen by reflected light because the incident light passes through the diffractive grating and is reflected back by the mirror coated on the reverse side. In the process, the incident white light is split into all the colors of the rainbow causing different aspects of the image to be seen in different colors when viewed at different angles. For this reason, such holograms are also referred to as ‘rainbow’ holograms.

Volume hologram. A volume hologram, otherwise known as a Bragg interference hologram, is formed as a result of changes in refractive index throughout the depth of a coating of material. The materials used to create such holograms are traditionally silver halide film or dichromated gelatine (DCG). In recent years, these materials have been joined by synthetic photopolymers (which have largely replaced DCG). Volume holograms must necessarily be reproduced by optical exposure followed by some form of processing. These replication methods are less convenient than the traditional embossing of surface relief holograms but the great advantage is the gain in image quality. Such holograms display both vertical and horizontal parallax creating a greater sense of realism.

2D/3D Holograms Holographic images in which depth is indicated by a series of two dimensional planes are known as a 2D/3D holograms. True 3D holographic images are of models or objects which, in themselves, occupy volume in space. The artwork for 2D/3D holograms is easy to produce because each layer is printed onto a two dimensional sheet. Stacking these sheets and making a hologram of the stack produces parallax effect which the eye perceives as image depth.

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