Elliptical lens designs and direct cut cylinder engraving technology

This article by Dr. Gary A. Jacobsen, Chief Engineer & President of Jacobsen Lenticular Tool & Cylinder Engraving Technologies (JacoTech), highlights an advantageous elliptical lens design and roll mould method developed by the company over the old industry method of copper plus post chrome plating. The firm provides solutions for optically-based cylindrical polymer/plastic materials processing, including the manufacturing of micro-structured optical-quality roll-surface mould components used for the management and control of light.

In the lenticular optical lens plastic/polymer processing industry today, the current old method of supplying lenticular/optical extruding cylinders consists of applying a soft copper base plating onto a steel green-based cylinder surface, which is then diamond turned and engraved. After the lenticular engraving, post chrome thin-flash plating is applied on top of the copper engraved plating, to help protect the soft copper finish underneath.

Disadvantages of the old method

Since copper metal has a very soft Rockwell hardness level of approximately 220 Vickers, it damages easily, especially during the engraving process (tearing) or from handling within the extruding facility.

Copper also begins to oxidise (change colour) immediately after engraving and has to be post plated quickly. Furthermore, it is easily susceptible to staining, which can then transfer into the lenticular lens material as a stain or artefact.

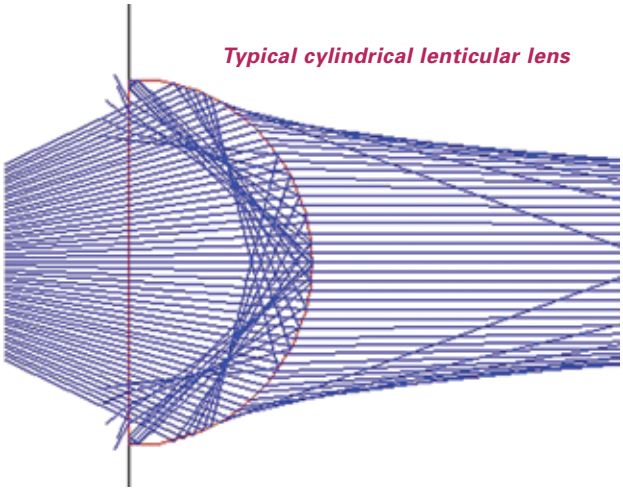
Post chrome flash plating is very thin (5-10 microns thin), which offers very little protection from nicks, scratches and handling of the cylinder. Chrome plating has inherent micro-cracks within the final plated finish and chrome does not deposit evenly across the cylinder width, therefore altering the quality of the lenticular lens materials across the master lenticular roll width.

Post chrome flash plating can detach itself from the copper engraved plating after short use, especially when extruding with acidic resins, such as PVC. This condition can render the cylinder useless and then it must be re-worked. Extruder production ceases and causes unnecessary delays and more expenses for extruders.

Post chrome flash plating can alter the intended optical lens design, by adding an undesired thickness to the copper engraved lenticulars. Plus, the addition of chrome plating on top of the copper engraved lenticular changes the profile to a more rounded undesired profile (knife like sharp peaks). The chrome post-plated lenticular profile develops a “land area” compared to a “knife-like sharp peak” lenticular. This can change the intended optical lens design negatively, creating possible optical quality problems when viewed as a cell, computer or TV screen.

Advantages of the new method

With a 55 Rockwell C hardness, JacoTech proprietary nickel/alloy plating is harder and will not damage as easily as copper. After engraving, the plating is also not susceptible to staining and will not transfer stains into the lenticular lens material, assuming the cylinder surface is cleaned properly.



Typical cylindrical lenticular lens

The single-ply integrated plating requires no post plating and is applied heavily to the green-based cylinder for best durability, meaning that it will not detach itself from the base. The plating also offers much better protection from nicks, scratches or from normal handling of the cylinder compared to soft copper; has an excellent surface finish, and is even across the entire cylinder width, thus helping ensure the quality of the extruded lenticular lens materials.

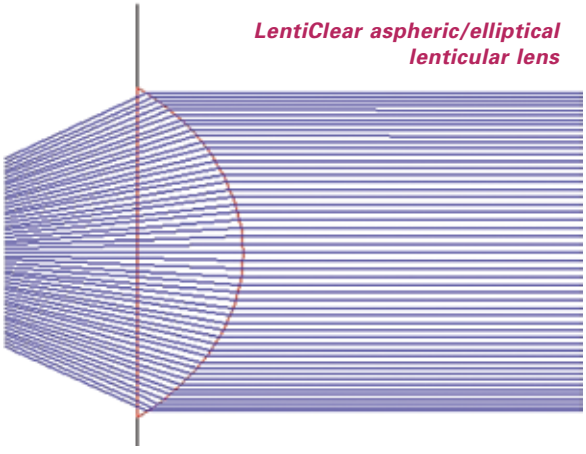
Since the optical design profile is engraved exactly into the JacoTech plating, it will not alter the intended optical lens design and maintains a "knife-like sharp peak" lenticular profile, allowing for the best optical performance compared to obtaining an undesired "land area" that will form when using the old post-chrome plating method.

The plating will also allow for the proper and intended non-imaged optical lens design to work for space films, solar panels, cell phone screens, computer screens or TV screens. By using the patented JacoTech optical lens design, patented diamond tools, proprietary single-ply direct engraving, JacoTech plating and advanced precision diamond turning technologies, we help save the extruder time and money in the manufacturing facility. The focus of JacoTech's custom optical micro-machining business is the ultra-precision CNC diamond turning, milling and fly-cutting of cylindrical drums, rolls and mandrels used to extrude/emboss/cast or calendar plastic and polymer-based sheet and roll films and materials.

Patented elliptical tooling and lenticular lens

The following schematics and explanations illustrate the numerous advantages of the patented LentiClear aspheric/elliptical lenticular lens, versus the typical industry standard cylindrical/spherical shaped lenticular lens that uses prior art and much older technology.

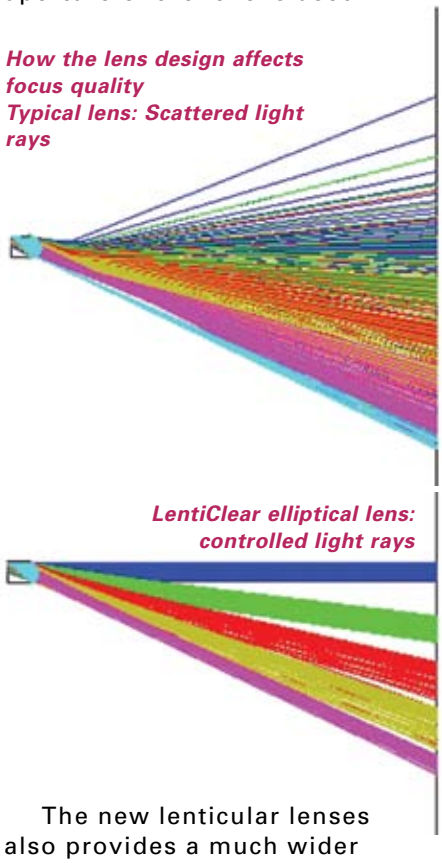
In the above illustration, the industry standard lenticular lens uses a cylindrical/spherical shape. (Note: The focusing point of the material is located to the left of the lens and the view is located to the right. For best performance, all of the light rays exiting the lens should be parallel or collimated).



LentiClear aspheric/elliptical lenticular lens

Due to a spherical aberration, only the rays in the central portion of the lens exit in this desired manner while the rays farther from the centre begin to significantly change from the desired direction. As the light rays reach the outer portion, the light can be seen to internally reflect, which ultimately returns the highly defocused light to the focusing lens material. This reduces the overall light output, brightness and contrast of the image when viewed through the lenticular lens material.

The new LentiClear lens (see above illustration) overcomes the shortcomings of the standard lenticular lens by utilising an optimised aspheric/elliptical shaped lens that effectively collimates the light from the focusing material, thus no light is internally reflected and the full aperture of the lens is used.



How the lens design affects focus quality
Typical lens: Scattered light rays

LentiClear elliptical lens: controlled light rays

The new lenticular lenses also provides a much wider field-of-viewing angle, as well as brighter, clearer and better contrast images than the typical cylindrical/spherical lenticular lenses.