



LEICA MANUFACTURING

The art of lens production.





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The art of lens construction.

Dear Photographer,

Leica Camera shares your passion for creative, sophisticated photography. For us, the most important factor is to guarantee superior image quality and maximum creative freedom. And for almost a century, this has been Leica's aim in the development of its cameras and lenses. As in the past, true masterpieces today are produced by hand in high-tech laboratories within the Leica factory, with the ultimate goal of being regarded by photographers as the best in the world. A combination of relentless precision, inexhaustible innovation, highly specialised expertise and absolute passion, not to mention invaluable experience, results in products of unrivalled excellence and quality.

Within this brochure, we hope to demonstrate the extraordinary levels of dedication and passion that go into the manufacturing of Leica products today.

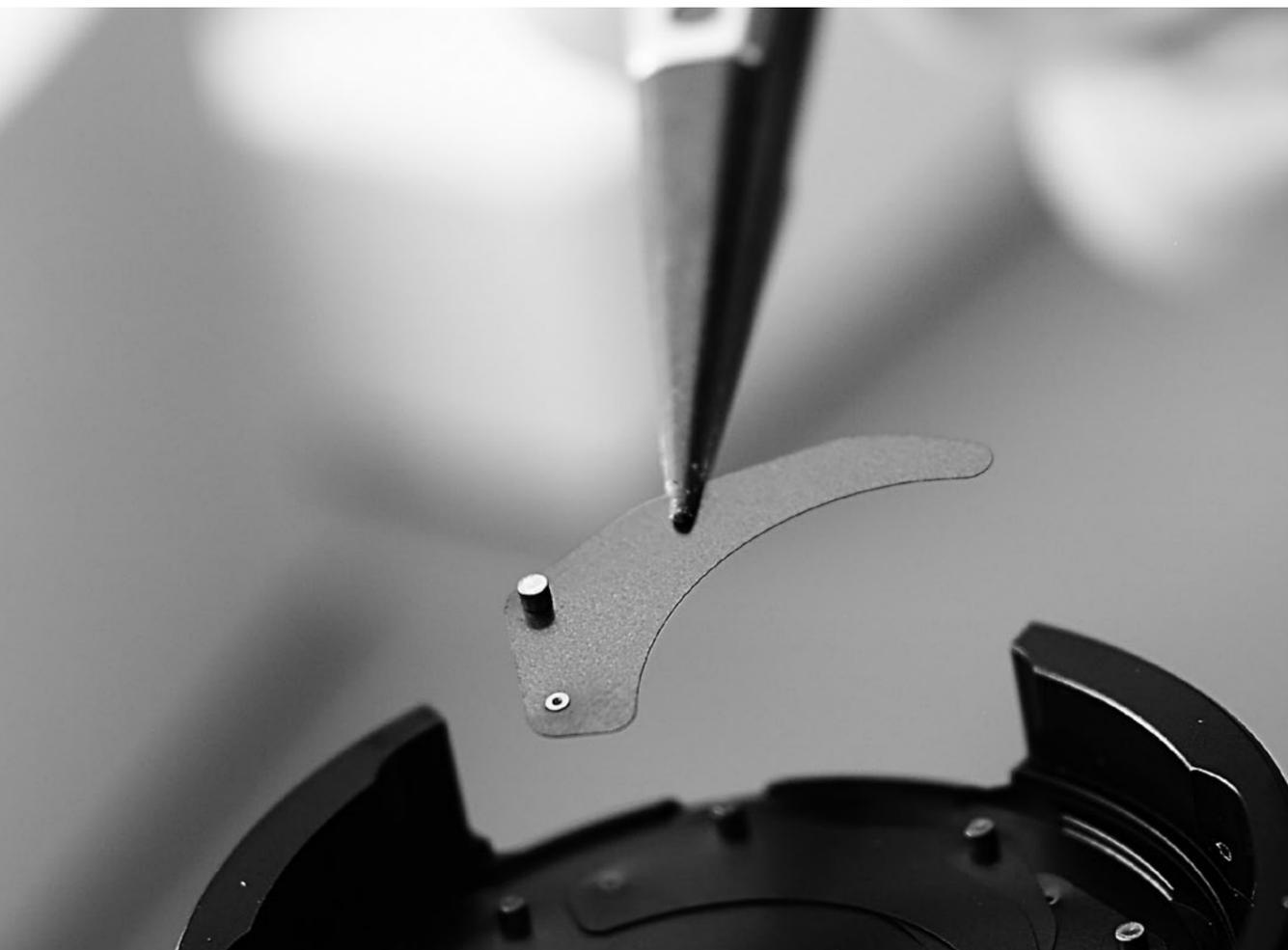
Yours,
Leica Camera AG

Every single Leica lens is constructed with absolute precision in a meticulous manual process.

LEICA LENSES

Each with its own unique talents.

Even the best camera can be let down if its optical performance does not meet the photographer's standards. This is why M-Lenses fulfil even the highest expectations. Each lens is the result of more than 150 years of expertise and experience in the design and construction of optical instruments. Every single lens must pass through numerous processes and quality assurance procedures, pass inspection by the discerning eyes of experts, and satisfy the criteria of exhaustive precision testing. No wonder that Leica lenses, which are 'Made in Germany', have become a synonym for quality. Not least because the quality that Leica demands has always been, and will always be, one thing: uncompromising.



HIGH-QUALITY GLASS

The first thing in the life of every lens is the choice of glass. Purity, as well as its reflective, refractive and transmission characteristics, can influence image quality from the start. Only the best optical glass is selected for the manufacture of Leica lenses. For the current lens portfolio, Leica needs around 100 different types of glass for the production of approximately 360 different lens elements. Our own glass laboratory, founded in 1948, formulated and patented many of these types of glass. Today, research and development in the Leica glass laboratory continues to ensure the highest quality: hundreds of glass types and test reports are immediately available for computer simulations and practical testing.

OUTSTANDINGLY FAST

The high transmission characteristics of all Leica lenses guarantee outstanding maximum apertures. Enormous effort is also invested in the minimisation of stray light around the lens elements and in the lens barrel by precision coating and perfected barrel construction. All glass surfaces are treated with high-performance antireflex coatings that are determined separately for each glass type using geometrical calculations based on all optical correction parameters. At Leica, the search for optical excellence is a passion. In their search, Leica engineers find not only the best solutions for guiding light, but also the most elegant.

EXCEPTIONAL IMAGING PERFORMANCE

To build the perfect lens, the laws of physics must be rewritten. Laws that also apply to Leica. Nevertheless, Leica engineers constantly strive to push the limits of the technically possible. A rewarding approach: M-Lenses have a very even imaging performance across the entire image field. There is no vignetting, and they are almost entirely free of aberration, yet they offer high colour saturation and precise colour separation.

MECHANICAL PRECISION

The best optical system will only demonstrate such performance qualities if the engineering of the lens barrel is just as precise. Depending on the lens, the effects of at least 50 construction parameters on imaging performance must be perfectly coordinated. Engineering with such precision is only possible by combining the latest technologies with the most meticulous manual skills, and naturally, in combination with only the highest-quality materials. Thanks to perfect functionality, intelligent construction and an absolute dependability that guarantees perfect handling at temperatures from -25°C to $+60^{\circ}\text{C}$, every single Leica M-Lens is a unique masterpiece of manual precision.

ASPHERICAL LENS ELEMENTS

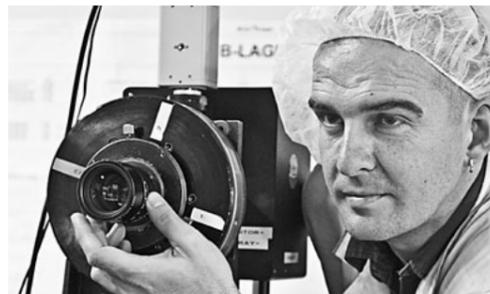
The majority of M-Lenses feature aspherical elements. In contrast to the symmetrical curvature of spherical lenses, their surfaces are characterised by asymmetry. This makes it possible to refract light rays at the edges of the lens element differently to those passing through its centre. This means that a single lens element can simultaneously perform several corrections. It is precisely this curvature that makes the production of such lens elements so elaborate. But the complex calculations are rewarding: aspherical surfaces minimise or avoid aberrations and are also the key to the compact size of M-Lenses.



LEICA LENSES

A synonym for quality that is 'Made in Germany'

It takes more than 30 processes to assemble around 100 individual components that make up an M-Lens. However, perfect tools can only be produced if components and sub-assemblies are painstakingly checked during production. Depending on the type, a lens therefore passes through up to 60 quality checks during assembly. Only when an M-Lens satisfies all criteria may it pass from the clean room to the quality assurance testing facility. There, every lens must pass numerous empirical tests and the most stringent functional checks – in six comprehensive testing facilities. Only perfect Leica lenses ultimately receive the inspection certificate as confirmation of their unique quality.



1 MTF ANALYSIS

Each lens may be considered in terms of two main assemblies – the 'focusing mount' and the 'lens head'. The latter contains the entire optical system that is tested after final assembly on a Modulation Transfer Function (MTF) system. An electronic camera captures the image of a back-illuminated slit with a width of only ten microns. The result of this enables the determination of contrast rendition and image field curvature. Both allow extremely accurate conclusions to be made about image performance and, in turn, the correct assembly of the lens.



2 INFINITY CALIBRATION

The aim of this calibration test is to check whether the sharply focused plane is truly at infinity when the focusing ring of the lens is set to the infinity stop. For this test, the two main assemblies are brought back together. In this process, an image captured by the lens is projected onto an electronic camera. The sharpness is optimum when image contrast is simultaneously at its highest. The distance between the bayonet flange and the optical system is calibrated by the insertion of extremely thin shims between the two main assemblies.



3 INTERNAL VISUAL INSPECTION

This step serves as a check to ensure that no dust, coating defects or other flaws are present inside the lens. Here, a light is viewed through the lens from both ends to reveal even the smallest dust particles on lens element surfaces or lens barrel components. At the same time, coating defects can be revealed by irregularities in the shimmering colours reflected from coated lens elements.



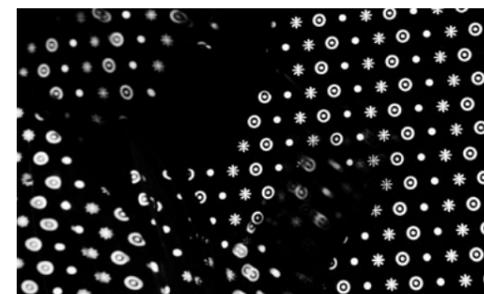
4 EXTERNAL VISUAL INSPECTION

This phase of checking involves all external surfaces of the lens. If these are flawless, and all smooth surfaces, knurled components and edges are faultlessly chromed, anodised or painted, the engraving can now be inspected. Only when these are also perfectly finished, with smooth, precisely painted edges, can the lens be passed to the next phase of quality assurance.



5 TESTING OF MECHANICAL FUNCTIONS

This test concerns the handling and smooth action of all moving parts. Experts check if the aperture, distance and focal length setting rings are free of play and rotate smoothly from all positions. The click stops of the aperture ring must also be clearly defined, and the lens hood must be extendable without wobbling, tilting or sticking – without twisting or turning.



6 VISUAL INSPECTION OF IMAGE QUALITY

The final phase is a comprehensive range of tests to check the imaging qualities of the lens. Here, the lens is fixed in a rotatable mount on a test bench, and a test image, such as Siemens Stars, is projected onto a screen. This again shows how precisely centred the optical system is and whether the image field curvature exceeds the calculated value. In addition, the degree of chromatic aberration correction can also be clearly recognised.

The Leica legend is built on precision tools, manufactured with the most painstaking care and uncompromisingly strict standards of quality. Every photographer who selects a Leica lens chooses not only a companion of lasting value, but above all an object of fascination and passion.



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