9. Ghosting, flares and transmission

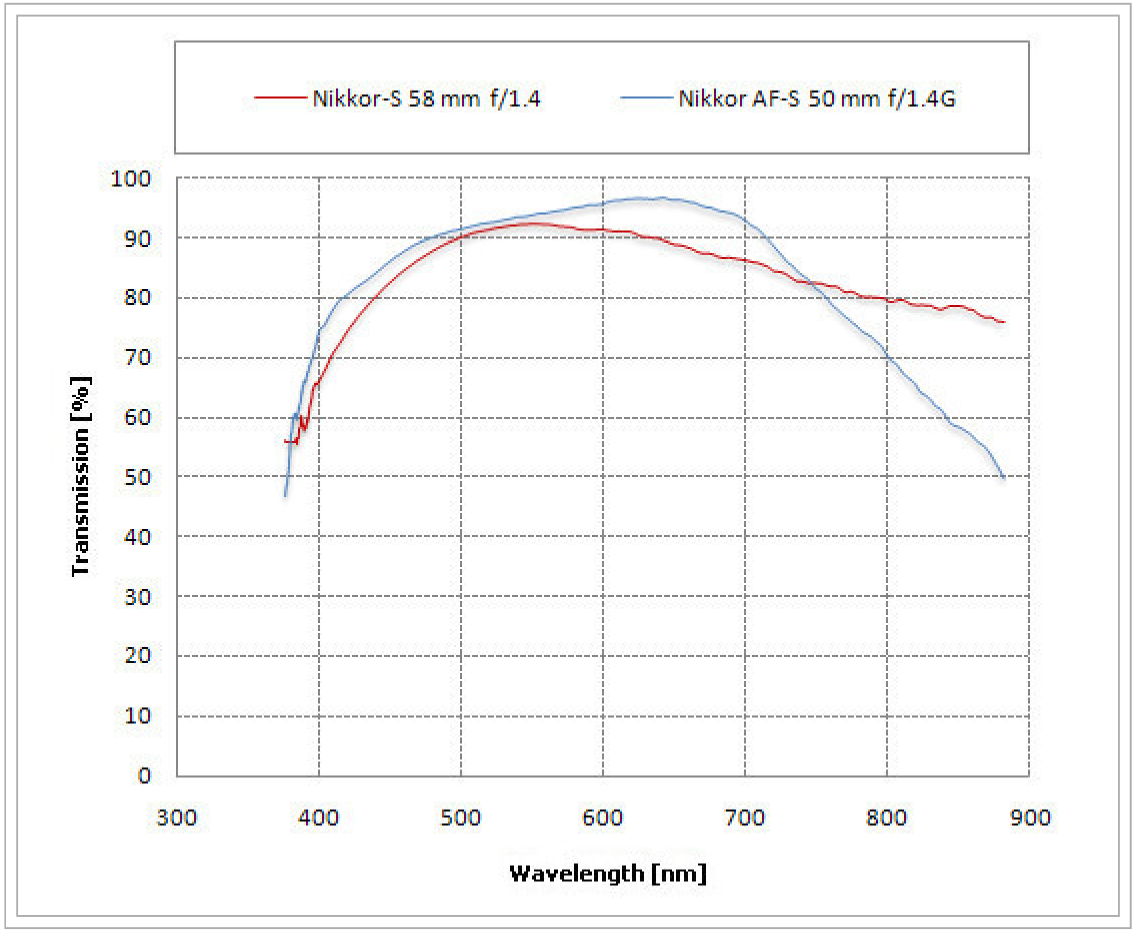
In the nineteen-forties antireflection coatings were first introduced in photographic lenses and their task was to eliminate light reflections on the air-glass boundary, thus increasing the transmission of an optical instrument and removing unwanted reflections. At the beginning single-layer coatings based mainly on magnesium fluoride were used, which lessened the reflection of light on one medium boundary from around 5% to almost 1.5%. At the beginning of nineteen-seventies, around the same time, a few companies independently of each other started using multilayer coatings. Only then did we see Pentax' SMC coatings, famous Zeiss' T* coatings, Canon's SSC and Nikon's SIC in action.

The tested Nikkor-S 5.8 cm f/1.4 was manufactured in 1960, so more than a decade before introducing multilayer coatings. It's no wonder that we expected to see single-layer coatings made of magnesium fluoride, optimized to working in the middle of visible spectrum, so around 550-600 nm, and giving characteristic blue reflections.

A glance at the lenses showed the first intriguing thing. From the bayonet's side there were no surprises, as we were welcomed by a blue shade typical of fluoride layers. However, when we looked at the large front lens, surprisingly, we saw, apart from blue, delicate but visible amber shade. It can be seen quite well in the picture below.

Our first conjecture was that that we were still dealing with single-layer coatings, but different – that is optimized for different wavelengths – on individual lenses. This hypothesis was suitable as Nikon was the first company to introduce multilayer coatings on different boundaries, while the first SMC or T* coatings were the same on every lens.

Our hypothesis was up in the air when we looked at the graph of measured transmission, we present below.



There are no doubts that modernly produced Nikkor AS-S 50 mm f/1.4 is in every aspect better than the half-a-century older lens. Its transmission is higher for every wavelength of visible spectrum, from 2 to almost 9%. Not until close infrared (wavelengths longer than 750 nm) does the old Nikkor begin to predominate over the new one. But this is the range a human eye doesn't register.

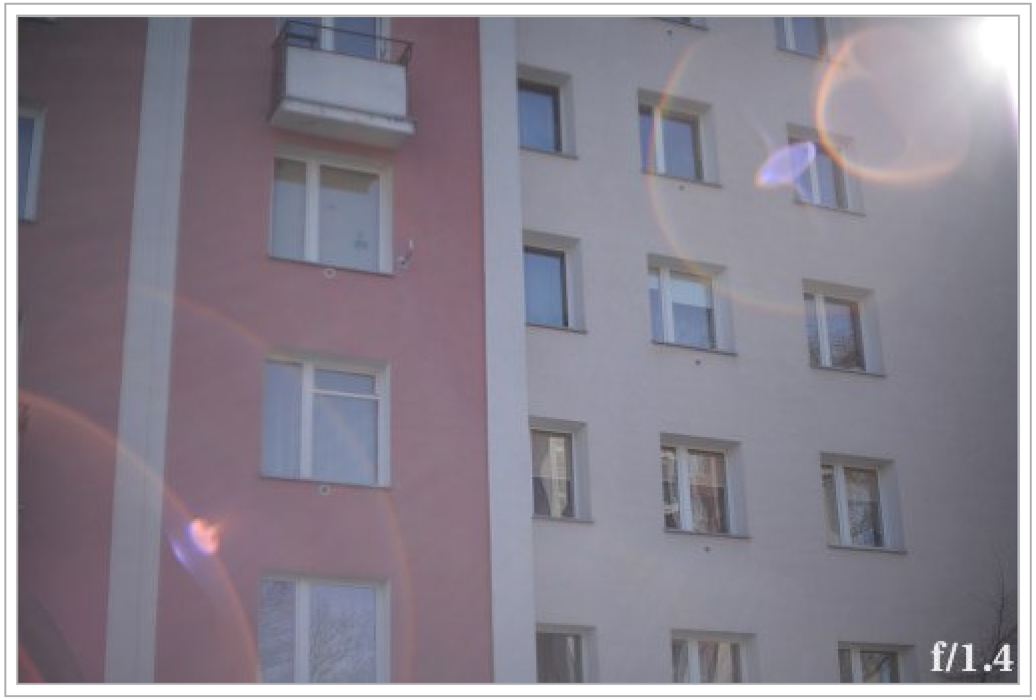
What surprised us most was a relatively small difference between the lenses, thus the high level presented by the old Nikkor. For the middle of the visible spectrum, i.e. regions of 550 nm the recorded result of 92%. It is one thing worth to mention about the classic magnesium fluoride coatings which were very popular in the fifties and the sixties of the last century. For the one air-glass boundary they assured the loss of light on 1.4% level, and only for the wavelength for which they were optimized. Taking this into consideration, in the case of 6 groups of elements we have 12 boundaries between glass and air and the transmission of the lens should be around 84% only.

Assuming that the Nikkor-S 5.8 cm f/1.4 has just one-layer coatings, optimized for 550 nm wavelength, then our result of 92% means that on one boundary there's only 0.7% of light lost. As a matter of fact, the situation is even more serious, because a different color of reflections suggests that coatings are optimized for different wavelengths, what should cause a flatter curve of transmission, but also bigger problems in getting high transmission for any particular wavelength.

What's the most likely solution? We can assume that Nikon used a better and more efficient material than magnesium fluoride, which in spite of using only one layer, can eliminate reflections on medium boundaries to a level of 0.7%, i.e. twice less than its competitors.

What's intriguing, the second alternative is even more interesting. Colorful reflections, changing slightly their shades depending on the angle of viewing, high transmission – these are all features of multilayer coatings! Is it possible, then, that already in 1960, so 11 years before Pentax SMC coatings' of seven layers debut, Nikon worked quietly on their own patent? Is it possible that, not boasting to everybody, they used simple 3-layer coatings a decade before its competitors? Who knows…

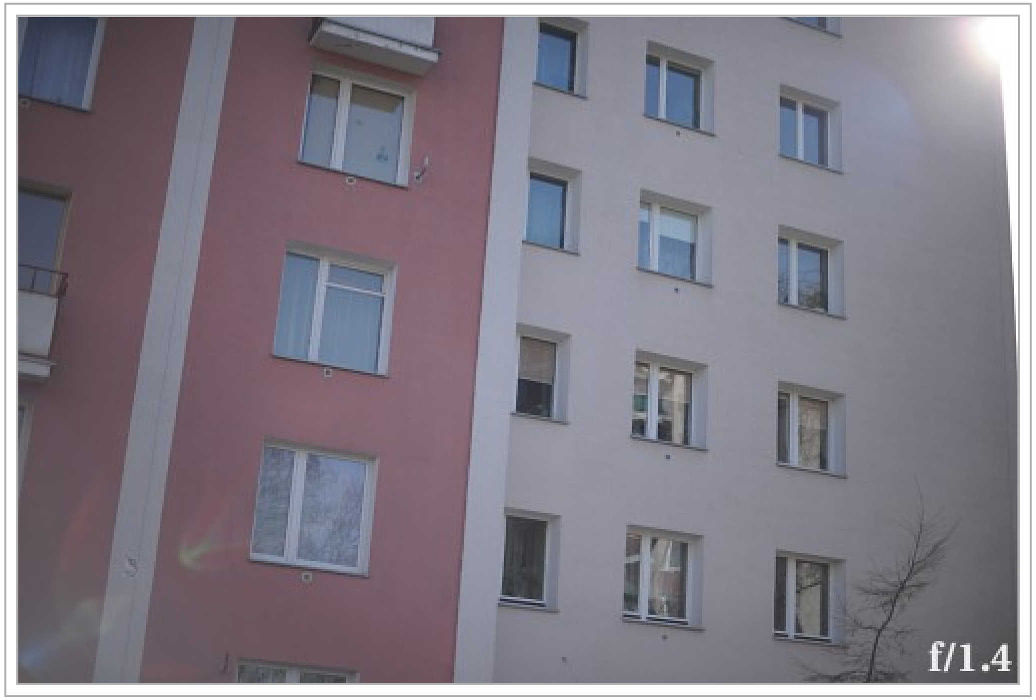
Although we can only praise the transmission, because for a 50 year old lens we got much more than we expected – laws of physics are implacable. In the blue range of spectrum the lens loses over 20% of light and in red even 15%. Something must happen to this light, and what does happen can be observed in the picture below.

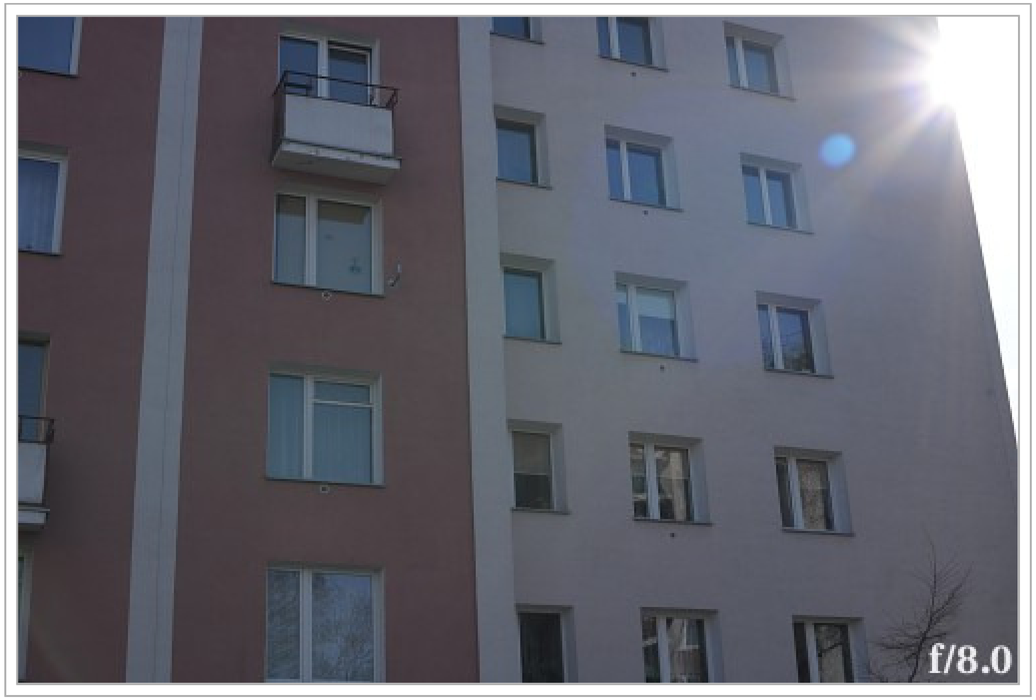


When working against bright light, reflections are distinct. This is influenced not only by transmission, which for light falling at an angle is even smaller than the one on the graph (obtained for rays falling in the optical axis), but also the mechanical construction of the lens, with a big front lens, covered by practically nothing from the sides.

When we stop down, situation improves and light artifacts become smaller. By the way you can see what diaphragm and number of blades we're dealing with.

Its younger brother can show Nikkor-S how to work against bright light. In its case light artifacts, both for f/1.4 and for f/8 are noticeable smaller, what can be observer in the pictures below.


f/1.4


f/8.0