

Upstream and industrial characterization of lenslet-based myopia control lenses

Alfatimi B., Bessenay. T, Genty E., Ged G, Hugonneaux P., Moisset C.

EssilorLuxottica – Global Lens Innovation, CIT, Créteil, France

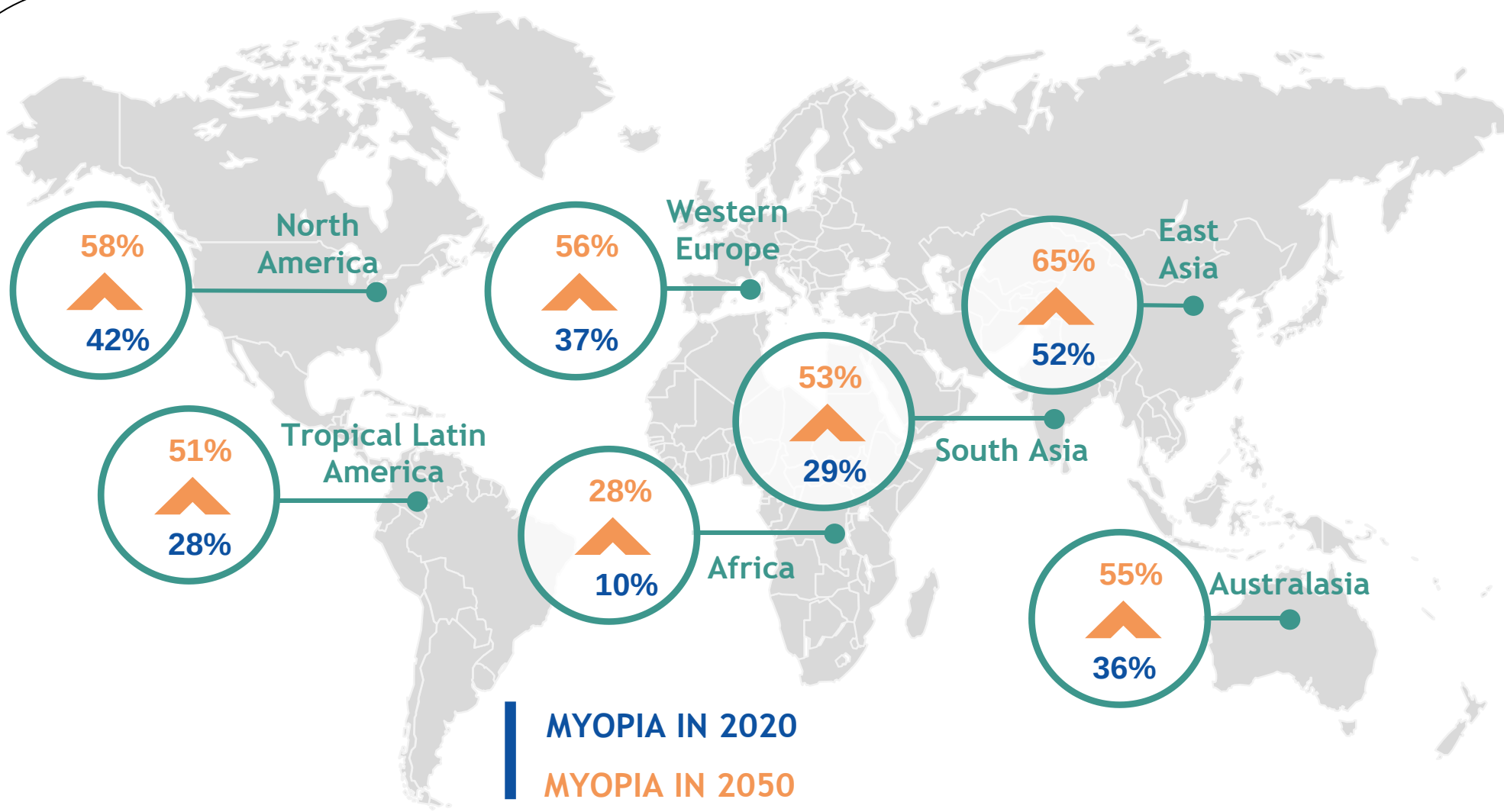


figure 1. Myopia prevalence in 2020 and projected prevalence in 2050
from: Holden BA, Fricke TR, Wilson DA, et al. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036-1042. doi:10.1016/j.ophtha.2016.01.006

General context

The world is facing a global myopia pandemic. Projections depict that half the world population should be myopic by 2050 as indicated on the prevalence graph on figure 1. Myopia increases the risks of severe medical complications at old age, such as age-related macular degeneration, retinal detachment. This pandemic is a public health concern in Asian countries where the myopia prevalence is today above 52 %.

In order to tackle this pandemic, ophthalmic optics industry has been proposing optical lenses that are no longer a mere prosthetic but an actual medical device, able to limit the onset of myopia for children. A significant part of these spectacles are based on lenslets that induce a limitation of the eye axial elongation. While the physiological mechanisms of this induction are not fully known, the efficiency of such lenses is measured through clinical trials.

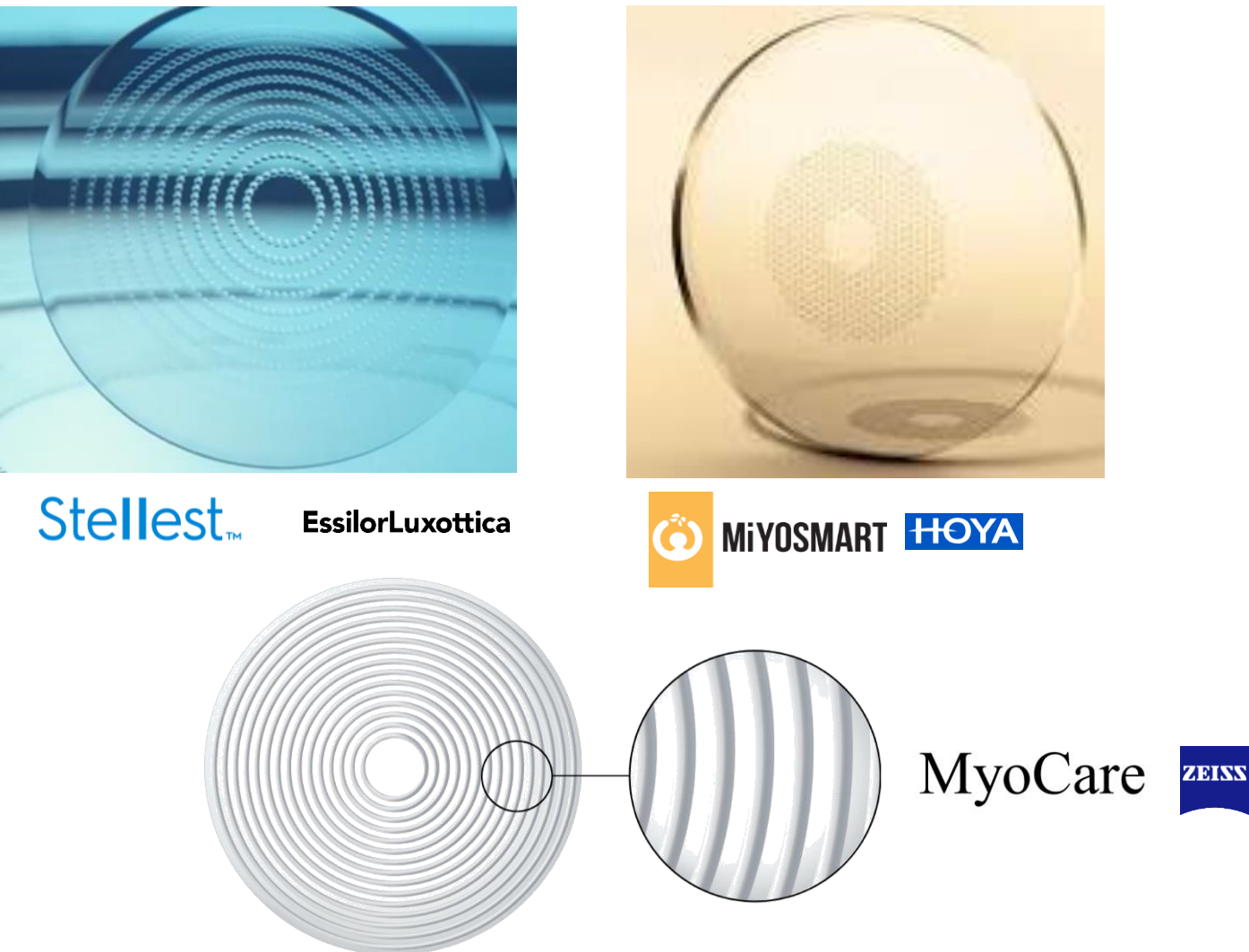


figure 2. Example of myopia control lenses by key industrials in the field

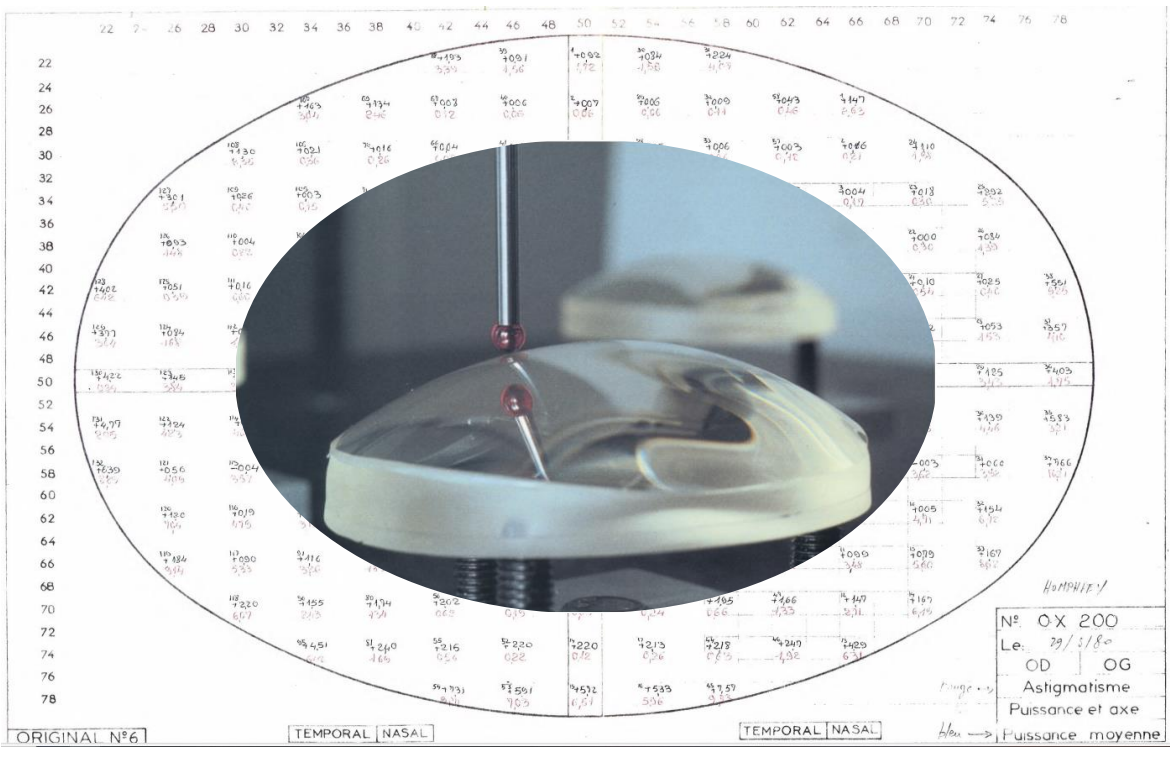


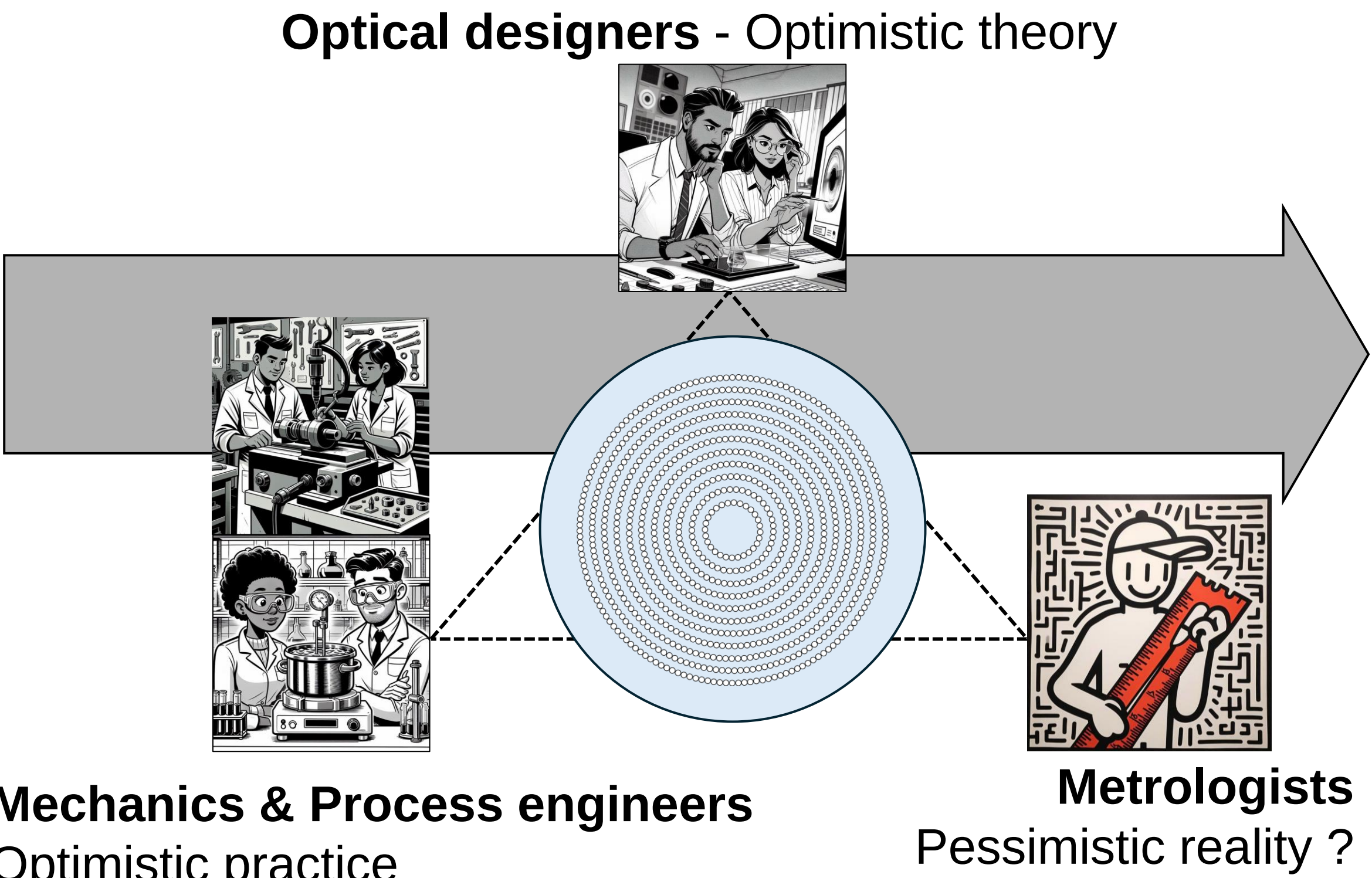
figure 3. Earlier characterization of a progressive lens

EssilorLuxottica invented the progressive lens. Such developments were made possible through the use of strong dimensional metrology culture within the group.

With the development of myopia control lenses, coordinates measuring machines (fig.3) became irrelevant to measure the characteristics of the thousands lenslets they are based on.

We had to propose an evolution of our measurement capabilities to bring agreement between design, process and metrology.

Changing our classical approach



In the first innovation stages: long measurement time, lower uncertainty

- Coherence Scanning Interferometry measurements (fig.4)
- High resolution surface topographies (XY ~5 µm, Z~ a few nm)
- Full lens reconstruction (10 h measurement)
- Possibility to study structures right beneath the lens surface
- Iterative approach to ensure agreement between design and realization

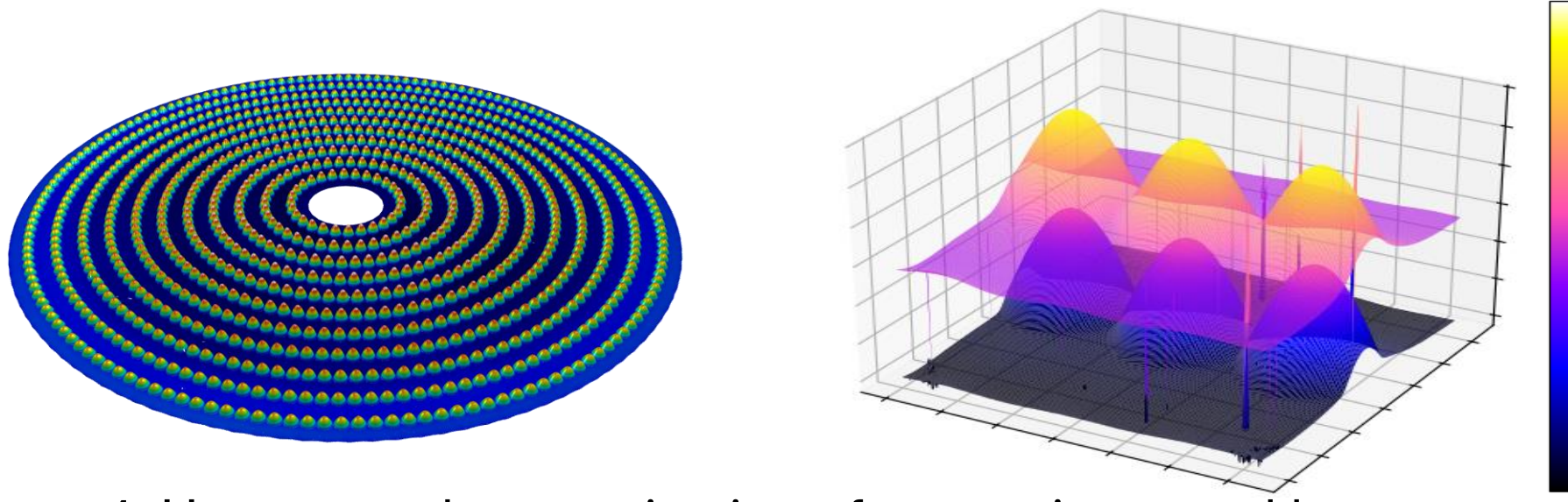


figure 4. Upstream characterization of a myopia control lens : topography and hardcoat

In the process control stages: short measurement time, higher uncertainty

- Neither Phase Measuring Deflectometry nor Fringe Projection Profilometry
- Expresses optical power through calibration of a derivative phase map. (fig.5)
- Spatial resolution : 45 µm
- Field of view : 10 cm ø
- Optical power range [-10 δ ; 5 δ]
- Uncertainty ± 0.1 δ
- One Full lens measurement <1 min

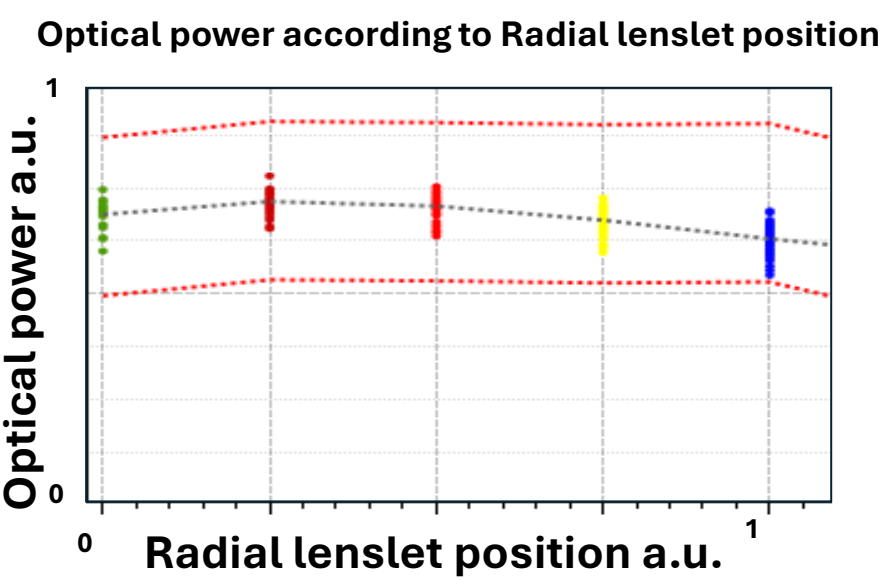


figure 5. Process characterization of a myopia control lens : power maps and power charts

Which traceability ?

Our upstream interferometric device is used to measure topographies. Its metrological traceability is established towards dimensional standards calibrated by a national metrology institute (fig. 6). A significant activity of our labs is to work on the evaluation of the limitations of this instrument. We constantly reevaluate our capabilities according to the new lens designs. Our downstream deflectometric device relies on calibrated power lenses. These standards are calibrated in thickness, curvature and refractive index so has to express their values in diopters (δ) (fig. 6).

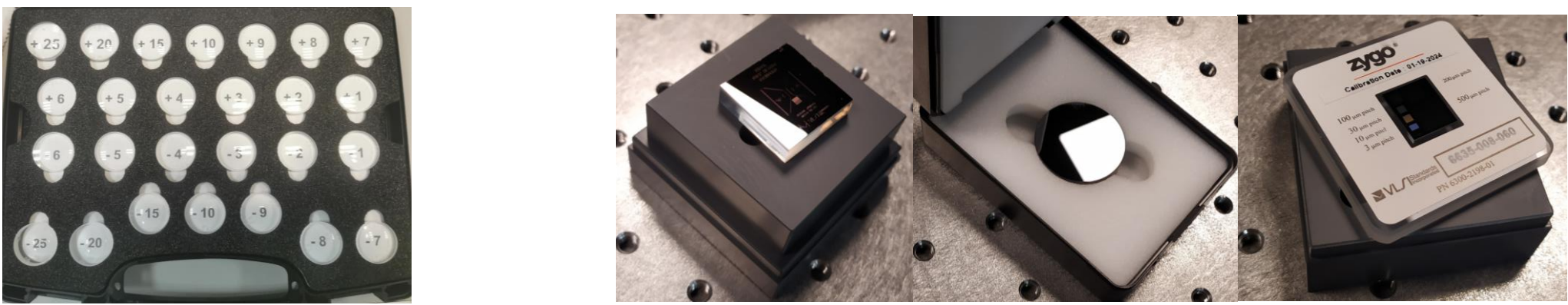


figure 6. Standard artefacts (commercial and in-house) used on our instruments

We also investigate new metrological axes applied to our lenses in the field of photometry and visual appearance measurements.

What standards ?

- Due to the dual function of myopia control lenses both therapeutic and prosthetic, these objects may be adressed by several normative referentials.
- Currently there is no definition of myopia control lenses within ophthalmic lenses standards. Those are so far considered as single vision lens ISO 8980.
- In Asia, where the myopia pandemic is a well-shared concern, local standards regarding the manufacturing quality of myopia control lenses are being developped.
- According to national public health politics, myopia lenses can also be classified as medical devices described by ISO13485 : 2016.

Despite the quantity of lenses produced by ophthalmic optics manufacturers, very few commercial equipments to measure lenslets based myopia control lenses exist while every major brand has developed in house dedicated instruments. The need for metrological intercomparisons of instruments able to characterize lenslets is critical.

Conclusion

In order to adress the growing prevalence of myopia pandemic, actors from the ophtahmic optics domain rely on several therapeutic techniques. One of those relies on the use of myopia control lenses. While EssilorLuxottica had a strong position on dimensional metrology applied to presbyopic lenses, this expertise was not applicable to lenslet based myopia control lenses. We had to develop a double approach, to describe both aspects of the manufacturing process in its upstream and mainstream application. We use absolute topographic measurements for R&D purposes. These characterizations are long and bear a low uncertainty level. Regarding the process control, we use a relative measurement based on deflectometry to render a fast conformity verdict, with a higher uncertainty but compatible with an industrial production mode. While the research is moving rather fast to understand the mechanisms behind myopia control, it is noteworthy to remark that the need for commonly accepted standard artefacts, intercomparisons and standardization is stronger than ever in this highly competitive field.