

OPHTHALMIC GLASSES



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Field

The present invention relates to ophthalmic glasses, particularly though not solely to
5 glasses for the prevention of myopia or the retardation of myopia progression in
children.

Background

Myopia (Nearsightedness) is a condition where the eyeball is too long, or the cornea is
10 too steep and the light coming into the eye is focused inside the eye rather than on the
retina – at the back of the eye, as shown in Figure 1. As a result those with myopia see
nearby objects clearly but distant objects appear blurred.

The prevalence of myopia in the Asia is significantly higher than in the western world.
15 Myopia is the most common eye problem among children in the Asian progressive
societies such as Singapore, Hong Kong, Taiwan and Japan. The condition is on the
rise in China, as education systems become more demanding. The prevalence and
severity of myopia have increased significantly over the past two decades worldwide.
Statistics and medical evidence show that myopia progresses significantly from age 6
20 to 15.

In Asia, myopia progression in primary school children is the highest in the world. In 7-8
years old children Myopia progresses at the rate of more than 1D (100 degrees) per
year. Myopia affects 25% of seven year olds, 66% of 12 year olds, and 80% of 18 year
25 olds. By the time these children reach adulthood, their myopia could be -8D or more!
Children need stronger glasses as often as once a year and even once every 6 months.



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Myopia became a problem of public health concern in Asia. High level of myopia is not only an esthetical issue but it is a health issue as it increases significantly the risk of irreversible blindness at older ages. Various eye pathologies such as Macular Degeneration, Glaucoma, Retinal Detachment and retinal problems following cataract surgery are at much higher prevalence.

The common and traditional practice for myopic children is prescribing them with a pair of eyeglasses with concave lenses that are shifting the image focus backwards towards the retina, resulting in clear vision. Eyeglasses are not preventing the development and the progression of myopia. They are just an optical correction to the eye optical dysfunction that allows children see clearly despite their optical dysfunction.

Why myopia develops and how could myopia progression be stopped?

While scientifically, the causes of myopia development are not totally determined, studies show that myopia progression is caused by a combination of genetic and environmental factors. Myopia is much more common where one parent is myopic, and more common still with two myopic parents. However environmental factors are equally crucial. The key environmental factor is extensive reading and near work. Studies show that increased hours spent focusing close up, reading and sitting in front of a computer screen are strongly correlated with myopia progression.

Myopic children are usually prescribed with eyeglasses that correct their myopia – the distance vision deficiency. When we focus on near objects such as reading a book, the light enters the eye and focuses beyond the retina. In order to shift the light focus back to the retina, the lens in the eye must change shape to add focusing power to the eye. This process is called “accommodation”. Studies show high correlation between extensive accommodation and myopia progression.

There are two main theories explaining the correlation between accommodation and myopia progression:

- a. Excessive accommodation associated with near work places a load on the eye during development. This load could be reduced by increased growth of the eye, resulting in myopia. Some studies that measured the eyeball length have shown that the eyeball elongates during accommodation process
- b. Insufficient accommodation when children are engaged in near-work activities ("Accommodative lag") is evident in many children (in some children more than in others). Accommodative lag results in hyperopic retinal defocus, excessive hyperopic defocus may trigger the visual regulation mechanism of ocular growth and elongate the eye

Being aware of the strong correlation between accommodation and myopia progression, researchers conducted studies proposing various ways to minimize the amount of accommodation in children's daily life, and by this means to reduce myopia progression. One way for eliminating accommodation reducing myopia progression is using bi-focal glasses or progressive lenses as shown in Figure 2. The principle behind this idea is that reading is performed using the lower segment of the glasses. Upper segment provides the required refractive error correction for getting distant images focused on the retina while the lower segment is designed to focus on close objects. (+2D - +3D from distance correction). In this case no accommodation of the eye is required while reading or doing near activities.

Bi-focal or Multi focal lenses are effective in providing refractive correction for both distance and near vision for adults who suffer from decrease in accommodation range. In this case the person is enforced to use the lower segment for reading, because at

the absence of accommodation capability, reading through the upper zone will result into a blurred image.

However as children have strong accommodation capabilities, there is no assurance
5 that the child will really use the lower part of the lens for near activities. While using the standard Bi-focal or Multi-focal lenses, there is no mean to enforce the child to reframe from accommodation and move his look using the lower segment of the lens while reading.

10 There are several studies investigating the use of progressive lens. A multicenter, randomized, controlled trial in the United States, Correction of Myopia Progression Trial (COMET) in which progressive lenses were used, reports small but statistically significant effect of the progressive lenses in slowing myopia progression. An additional randomized controlled trial in Japan using progressive lenses in children
15 shows a similar positive effect of progressive lenses in slowing myopic progression.

However, the reported effect in those studies in retarding myopia progression is not practically substantial. Only about 25% reduction is shown. The main reason for the limited effect may be that children using progressive lenses tend not to switch and use
20 the dedicated zones on their lenses for reading (the lower zones). Since their accommodation capability may be strong, children can read equally well by using the upper (distance) segment of the lens and performing accommodating. It is much more comfortable and intuitive to use the upper part in the lens all the time and apply accommodation when reading, rather than tilting the head and looking down.
25 (While at the beginning children may collaborate and try using the reading zone in the lens, as time passes, they learn that using the upper part of the lens is not really necessary as it would not induce blur during near work, unlike in adults who are

presbyopic, and thus, it is difficult to expect children to force themselves looking down, it is counter intuitive and inconvenient. Therefore they may stop using the reading zone, and simply use the upper – distance zone and continue accommodating).

While bi-focal or multi-focal glasses can reduce significantly accommodation needs and
5 thus have the potential to slow down myopia progression, the way these glasses are practically used by children limits the efficacy and as a result has hardly any effect on myopia progression.

Additional Bi-focal or Multi-focal clinical studies with myopic children have shown
10 similar limited and inconsistent effect for this reason.

Summary

In general terms the invention proposes that glasses prescribed to treat myopia (rather than correct it) are configured to encourage children to use the upper lens for distance
15 viewing and the lower lens for near viewing (rather than accommodate using the upper lens).

This may have the advantage that the treatment of myopia in children is more efficacious.

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In specific expressions of the invention there is provided a pair of glasses according to claim 1 and/or methods according to claims 22, 23 and 25. Embodiments may be implemented according to any of claims 2 to 21 and 24.

25 Brief Description of the Drawings

One or more example embodiments of the invention will now be described, with reference to the following figures, in which:

- Figure 1 is a light ray diagram of a eye with myopia;
- Figure 2 is a front view of prior art bifocal lenses;
- Figure 3a is front view of the ophthalmic glasses according to the example embodiment in a distance viewing configuration;
- 5 Figure 3b is front view of the ophthalmic glasses according to the example embodiment in a near viewing configuration;
- Figure 4 is a perspective view of a further example embodiment;
- Figure 5a is a schematic diagram of the LC shutter in Figure 4;
- Figure 5b is an exploded view of the LC shutter and the lenses in Figure 4;
- 10 Figure 6 is a schematic diagram of the proximity sensor in Figure 4;
- Figure 7 in a wiring diagram of the glasses in Figure 4;
- Figure 8 is a block diagram of the electronic components in Figure 4;
- Figure 9 is a flow diagram of a method of manufacturing of the ophthalmic glasses according to the example embodiment
- 15 Figure 10a is a side view of a prior art lens and frame prior to installation;
- Figure 10b is a side view of a prior art lens and frame prior after installation;
- Figure 11 is a side view of the two part lens;
- Figure 12 is a close up of the edge of the lenses;
- Figure 13 is a close up of the groove in the frame;
- 20 Figure 14 is a side view of the front lens being inserted; and
- Figure 15 is a side view of the back lens being inserted.

Detailed Description

- Figure 3 shows a pair of ophthalmic glasses 300 using progressive or bi-focal lenses to
- 25 treat or retard the progression of myopia in children according to the example embodiment. The lenses utilize a mechanism that forces the child to use the lower segment 302 of the lenses while reading. This will ensure that no prolonged

accommodation (or minimum accommodation) is applied to view up-close objects and as such will expectedly reduce significantly or prevent completely myopia progression in children.

- 5 The glasses optical lens (bi- focal or progressive lens) incorporate a special Transparency Controlled Liquid Crystal film (TCLC) 304. The film 304 can change states from being completely transparent to a “milky”, frosted, opaque state.

The TCLC 304 transparency is controlled electronically. While the child is reading, the
10 upper segment 306 of the lens turns automatically opaque. This forces the child to utilize only the lower segment of the lens, which has optical power prescribed for reading, avoiding the need to apply accommodation. When looking at distant objects the TCLC 304 becomes completely transparent and the eye naturally uses the distance refraction segment of the lens (upper part) 306.

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As shown in Figure 4 the electronics are embedded in the glasses frame. The electronics include a CPU programmed with software 400, TCLC film voltage drivers, proximity sensors 402. The circuit power is provided by low profile multiple polymer lithium rechargeable batteries 404. The batteries 404 are charged using wall adapter
20 with industry standard micro USB connector 406.

Smart activation

The glasses are activated automatically upon wearing the glasses. This is done via a touch or body sense sensor 408 located at the nose pad 410 of the glasses. There
25 may be a sleep function for ultra low power consumption which activates if the glasses are not worn for an extended period.

Frame

The glasses frame may be Grilamid TR90LX material or similar. The Nose pad 410 may be conductive silicon biocompatible for skin touch. The Temples edge 412 at ear may be soft silicon long touch biocompatibility for skin touch and adjustability. The
5 silicon at the nose bridge and temples / ear pieces may avoid the glasses slipping down the child's nose due to the extra weight of the glasses. The arms may be fixed and not foldable.

TCLC

10 The TCLC may be 0.2-0.3 mm thick and driven by a square wave 20-28VV. There are 2 active cells operated independently for each eye. Alternatively 3 active cells per each eye would be considered, dividing the lens into 3 different zones. Each cell is a LC film is located between the 2 optical lenses with a conductive tab 4 having conductive lines for cell activation inserted into a slot in the frame as shown in Figure 5. The tab is thus
15 a Quick Assembly Mechanism (QAM) to enable "Field " Assembly (by Optician) of the LC shutter and electrical connectivity to the electrical board. Disassembly for lens exchange is performed by the Optician easily in as well

The TCLC may be opaque without power and clear when energised, or the other way
20 round. The level of opaqueness may be chosen as only partially opaque as a safety feature.

CPU

As shown in Figure 8 the CPU is located on a main PCB board with the proximity
25 sensors welded to the circuitry. The Battery is connected to a small PCB. TCLC pads are provided on the Main PCB and Small PCB. Interconnection wiring from the left arm to the right arm and nose pad is provided through the frame as shown in Figure 7.

The CPU is low power, small foot print, low cost CPU with flash memory and wireless communication option. It has an output voltage to drive LC 20-28V square wave (amplitude).

5

Management software

A remote computer may be wirelessly or through a micro USB port connected to the CPU and include management software. This may allow reporting of data such as "Wear time", "Reading time " and additional information for clinical data collection.

10 Parameters such as smart activation may be configurable.

Reading state detection

This detector identifies when the child is reading or doing other near work, and turning automatically the upper lens (the distance zone) to be opaque. While looking at
15 distance again, the detector identifies the new position and clears the upper part of the lens.

As shown in Figure 6 the detector may be an ultrasonic piezo sensor, transmitter and receiver driven by a square wave (amplitude). There may be a transmitter on one side,
20 and a receiver on the other side, although a central combined Tx/Rx transducer is also possible. The sensor should be small, not larger than 9mm in diameter and 5mm in length in a fully closed metal case.

An example sensor is a closed case sensor 8 mm in diameter and 5mm in length
25 produced by Prowave, Taiwan. This sensor operates at 5-10 V at frequency of 40Khz and has a resolution of 1cm

The detector reader implements a smart recognition algorithm that may reduce false states situations. The switch to reading state is not done instantly but with a slight delay. Thus brief glances may be filtered out and only stable reading situations (where
5 prolonged accommodation is performed) activate the upper shutter. The purpose is to make it practical to the child, and eliminate “false activation”. In addition it enables the child practice normal accommodation.

Battery

10 The battery may be a rechargeable polymer Lithium battery 3.7V ~80-110mAh

Micro USB Connector

The battery may be charged via a charging module in the CPU. The charging module activates when an external AC- DC switching power supply , 5V is connected to the
15 USB micro charger port. The port is IP55 water and dust protected. Alternatively a solar charger may be provided either externally or as part of the frame.

Frame assembly method

As seen in Figure 9 the glasses (except optical lens and LC film) are assembled at a
20 production facility. The Lens (according prescription) and LC film are assembled by licensed central lab or qualified optician. All internal parts electronic board, battery and other parts are not replaceable. Due electrical induction shutter wiring should be apart from nose pad wiring.

25 Standard optical lens are held in glasses by various means. As shown in Figure 10 the most popular is by having a triangle groove in the glasses frame (standard dimensions of approx 2.2mm base 0.6 mm height). The Lens shape is hedged by a special

hedging devices that cuts the lens to fit the frame shape and leaves a protrusion around the circumference of the lens fitting the plastic or glass lens to the frame precisely. The lens is inserted into the frame either by loosening the frame by heating (in case of plastic frames) or loosening the frame by opening small screws that tighten the 2 parts of frame together.

As shown in Figure 11 the lens according to the example embodiment is split into 2 lenses. The optical power is summation of 2 lenses. For example the front lens is + 4 and the rear lens is minus 2.5 thus net optical power is 1.5 dioptre. The TCLC film is very thin (about 0.2 mm) thus has no influence on the image quality.

As shown in Figures 12 to 15 the front lens is smaller than the back lens and has a tapered edge that allows it to be inserted from the rear. Then the TCLC is inserted. Then the angle of the groove in the frame allows the back lens to slide into place from the back.

Lens prescription

The front lens may be a fixed prescription. It may be either bi-focal or multi focal with a near addition of +2.0D - +2.5D The front lens may be fixed without reference to the personal prescription of the user. The back lens may be personalised to the prescription for the child. prescribed to correct the individual child's myopia and astigmatism.

The advantage may be cost. Bi-focal or multifocal lenses may be more expensive. By ordering large batches of the same lens cost may be reduced. Because the back lens is a single focal lens, it may be cheaper to personalise to the prescription.

While example embodiments of the invention have been described in detail, many variations are possible within the scope of the invention as claimed as will be clear to a skilled reader.

Claims

- 1 1. A pair of ophthalmic glasses configured to retard myopia progression or
2 substantially prevent myopia in a child comprising:
3 a prescribed distance viewing lens portion,
4 a prescribed myopia treatment lens portion,
5 a variable transparency element configured with a near viewing mode by the
6 child with at least a portion of the prescribed distance viewing lens portion substantially
7 opaque or non transparent and at least a portion of the prescribed myopia treatment
8 lens portion substantially clear or transparent, and configured with a distance viewing
9 mode by the child with at least a portion of the distance viewing lens portion
10 substantially clear or transparent.
- 1 2. The glasses in claim 1 wherein the variable transparency element is
2 sandwiched between an inner lens and an outer lens.
- 1 3. The glasses in claim 2 wherein the inner lens is a prescribed lens for the
2 specific child and the outer lens is a fixed optical power lens.
- 1 4. The glasses in claim 2 or 3 wherein the inner lens is a negative diopetre lens and
2 the outer lens is a positive diopetre lens.
- 1 5. The glasses in claim 4 wherein the outer lens has a bevelled edge substantially
2 coterminous with an edge of the variable transparency element, and the inner lens has
3 a bevelled edge substantially spaced from the edge of the variable transparency
4 element.

1 6. The glasses in claim 5 further comprising a frame including a notch to
2 accommodate the inner lens bevelled edge and the edge outer bevelled edge, the
3 notch having a smaller circumference on an outer side compared to a larger
4 circumference on an inner side, the larger circumference on the inner side configured
5 to allow the outer lens, the variable transparency element and the inner lens to be
6 installed from the inner side.

1 7. The glasses in any one of the preceding claims further comprising a frame
2 including a silicon nose bridge and silicon ear pieces.

1 8. The glasses in any one of the preceding claims further comprising a controller
2 to determine whether the child is near viewing or distance viewing and to energise the
3 variable transparency element to the near viewing mode or the distance viewing mode
4 accordingly.

1 9. The glasses in claim 8 wherein the controller is configured to activate the
2 distance viewing mode substantially immediately after determining the child is distance
3 viewing and to activate the near viewing mode after a predetermined period of
4 determining the child is near viewing.

1 10. The glasses in claim 8 or 9 wherein the controller comprises a distance sensor
2 to determine the distance between the glasses and the most significant object in front
3 of the glasses.

1 11. The glasses in claim 10 wherein the distance sensor comprises a transmitter on
2 a first side of the gasses and a receiver on an opposite side of the glasses.

1 12. The glasses in claim 10 or 11 wherein the distance sensor is an ultrasonic piezo
2 electric transducer.

1 13. The glasses in any one of the preceding claims wherein the portion of the
2 distance viewing lens portion is only partially opaque in the near viewing state.

1 14. The glasses in any one of the preceding claims wherein the variable
2 transparency element is non transparent when unenergised, and transparent when
3 energised.

1 15. The glasses in any one of claim 8 to 12 further comprising a rechargeable
2 battery to power the controller.

1 16. The glasses in claim 15 further comprising a water sealed USB micro port
2 configured to connect an external power supply to the rechargeable battery.

1 17. The glasses in any one of the preceding claims further comprising a
2 communication module configured to send glasses operation data and compliance data
3 and/or receive updated settings or software from a remote unit.

1 18. The glasses in any one of the preceding claims configured to determine
2 whether the child is wearing the glasses and enter a low power mode if the glasses are
3 not worn.

1 19. The glasses in any one of the preceding claims configured to enter an ultra low
2 power mode if the glasses are not worn for an extended period.

1 20. The glasses in claim 15 wherein the controller is located inside an arm and the
2 battery is located inside another arm.

1 21. The glasses in any one of the preceding claims wherein the prescribed distance
2 viewing lens portion and the prescribed myopia treatment lens portion are part of a
3 Bifocal lens(es) or a progressive lens(es).

1 22. The glasses in any one of the preceding claims wherein the prescribed myopia
2 treatment lens portion comprising a near viewing lens portion and a intermediate
3 viewing lens portion, and the variable transparency element configured with an
4 intermediate viewing mode by the child with at least a portion of the prescribed
5 distance viewing lens portion substantially opaque or non transparent and at least a
6 portion of the intermediate viewing lens portion and the near viewing lens portion
7 substantially clear or transparent, and in the near viewing mode at least a portion of the
8 intermediate viewing lens portion and the prescribed distance viewing lens portion
9 substantially opaque or non transparent and at least a portion of the near viewing lens
10 portion substantially clear or transparent.

1 23. A method of fabricating ophthalmic glasses configured to retard myopia
2 progression or substantially prevent myopia in a child comprising:
3 installing an outer lens in a frame,
4 installing a variable transparency element adjacent the outer lens,
5 installing an inner lens adjacent the variable transparency element, and
6 electrically connecting the variable transparency element to a controller.

1 24. A method comprising:

2 measuring a degree of myopia and astigmatism in a child;
3 providing a distance viewing lens portion having an optical power based on the
4 degree of myopia and astigmatism,
5 providing a near viewing lens portion having an optical power designed to retard
6 myopia progression or substantially prevent myopia in the child based on the degree of
7 myopia, and
8 providing a variable transparency element adjacent the distance viewing lens
9 portion and/or the near viewing lens portion.

1 25. The method of claim 24 further comprising determining if the child has myopia.

1 26. A method comprising:
2 providing eyeglasses with a prescribed distance viewing lens portion and a
3 prescribed child myopia treatment lens portion,
4 viewing a distant object using the distance viewing lens portion, and
5 occluding the distance viewing lens portion when viewing a near object using
6 the prescribed child myopia treatment lens portion.