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Multi-Utility Glasses

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Abstract: **In this paper we try to present an innovative research oriented product designed as an optical accessory. The design of this product is based on a developable idea. The product is called GlassXx© as coined by the authors. It is a hybrid glass that can be used in a variety of modes depending upon the user and environment. The Glass is controlled by a neuro sensor connected to the user in the form of a head band included in the design powered by body heat. The lens used in these glasses are the multi layered, multi utility, electrically excited glasses that change their optical properties according to the control signal applied from the controller attached to the brain sensor and light intensity sensors. The brain waves of the patient are to be studied before using the glasses and a usable extraction is obtained from the data to allow the user to control the lens properties via the brain sensor.**

Keywords: **lens, BCI, brain sensor, waves, sensors, glasses, light, optical properties, frequency.**

1. INTRODUCTION

In the world of innovation, computing and wearables, technology is peeping into everything around us. Everything is becoming intelligent, automatic and connected. We would like to present a research idea about the same change that needs to be done to common eye glasses one uses and make it eligible to be called as intelligent glasses. We call them GlassXx©.

Ever wondered why one needs to change his spectacles every time he has to either read, work on a computer, to look far, to look near, to go out in sun and so on. It seems a little odd to do this trial daily in this advanced world wonder why hasn't anyone looked for a solution till now. We are just giving an idea worth developing. The concept of GlassXx© is just to have single glass capable of all the application, at least the most of them. A single glass that can be used to read, used as a computer glass, for daily use, as an anti-glare sun shades and much more. That would be a great help. The GlassXx© can be accomplished by first designing the multi-layered, electrically excitable glasses that can change their optical properties such as color,translucense,reflection coefficient etc. , light intensity sensors ,brain wave sensors and thermo couples.

2. HYBRID GLASSES

Presently the glass manufacturing technology is at its best. Any type of glass can be manufactured with any element/compound embedded in its structure. There are different types of glasses whose properties can be changed in a number of ways to make it multi-functional. Different kinds of such glasses are:

- Electro chromic glasses.
- Thermo chromic glasses.
- Suspended particle glasses.
- Micro binded glasses.
- Polymer dispersed LC glasses.

These are also known as smart glasses that are under research to produce multi-functional windowpanes. Out of these electro-chromic, SP glasses and micro bends are the ones we are interested in.

The basic idea of GlassXx© is to have a multi-functional eyeglasses that are controlled by our brain. Considering the electro chromic glasses as one option. Electro-chromic glasses are the ones whose optical properties change when a small voltage is applied to them. All the other types are actually electro chromic. Electrochromic glass is made of special materials that have electrochromic properties. *Electrochromic* basically describes materials that can change color when energized by an electrical current. Electricity generates a chemical reaction in this material. This reaction (like any chemical reaction) changes the properties of the material. In this particular case, the reaction changes the way the material reflects and absorbs light. In some other electrochromic materials, the change is between different colors. In electrochromic windows, the material changes between colored (reflecting light of some color) and transparent (not reflecting any light).An electro chromic glass is created more like a digital IC. It all starts with a glass or plastic substrate. All other layers are grown by the process of sputtering. Different layers of transparent metal oxides are created with a separator layer in between them. Transparent electrodes are also created on either sides of the separator.

Our glass lens should be formed in the same way. The inner electrode is made up of Lithium Cobalt Oxide ($LiCoO_2$) and the outer electrode is made up of Poly Crystalline Tungsten Oxide ($W0_3$). When no voltage is applied across the electrode contacts, the Lithium ions are in the layers near the inner electrode. This makes the glass to stay transparent. When we apply some voltage (1.2-3V), the ions migrate to the outer electrode through the separator and are soaked by it. This creates a reflector film on the outer side of the glass. This property of the electro-chromic glasses turns it into a sunglass by the burst of voltage at the electrodes in just few seconds. Another burst will bring it into its normal transparent form. It requires no power to keep in any of the two states, just a burst to change state.

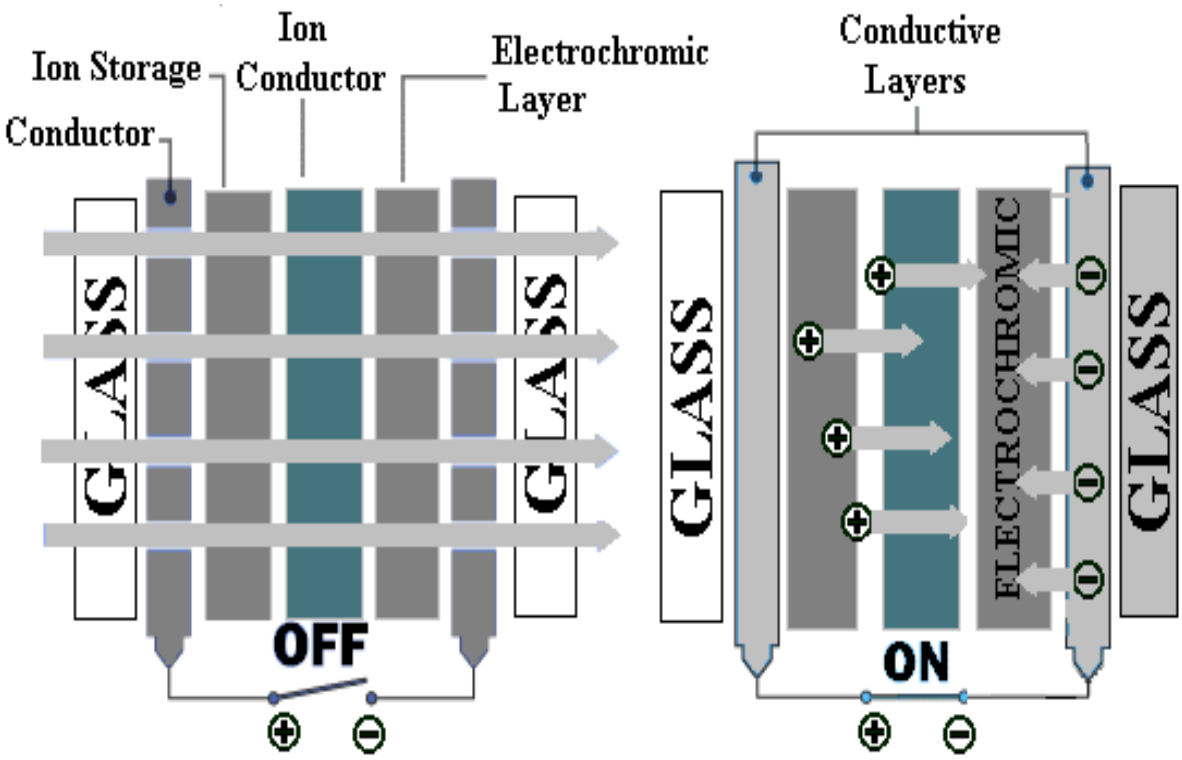

Fig 1: Basic Structure of Electro-Chromic lens

In case of a Suspended Particle Devices (SPDs also called *light valves*, they use either a liquid suspension or a film within which droplets of liquid suspension are distributed. They contain a glass film of rod like nano particles is suspended in a liquid between the 2 glasses sandwiched between the transparent electrodes. Depending upon the voltage applied we can change the order of tint / glazing of the glass. The mechanism behind SPD is similar to that of the dielectric in a parallel-plate capacitor which means that the atoms of the dielectric are polarized by the electric field. When an electrical voltage is applied to the suspension via the coatings, the particles are forced to align. This allows a range of transparency where light transmission can be rapidly varied to any degree desired depending upon the voltage applied.

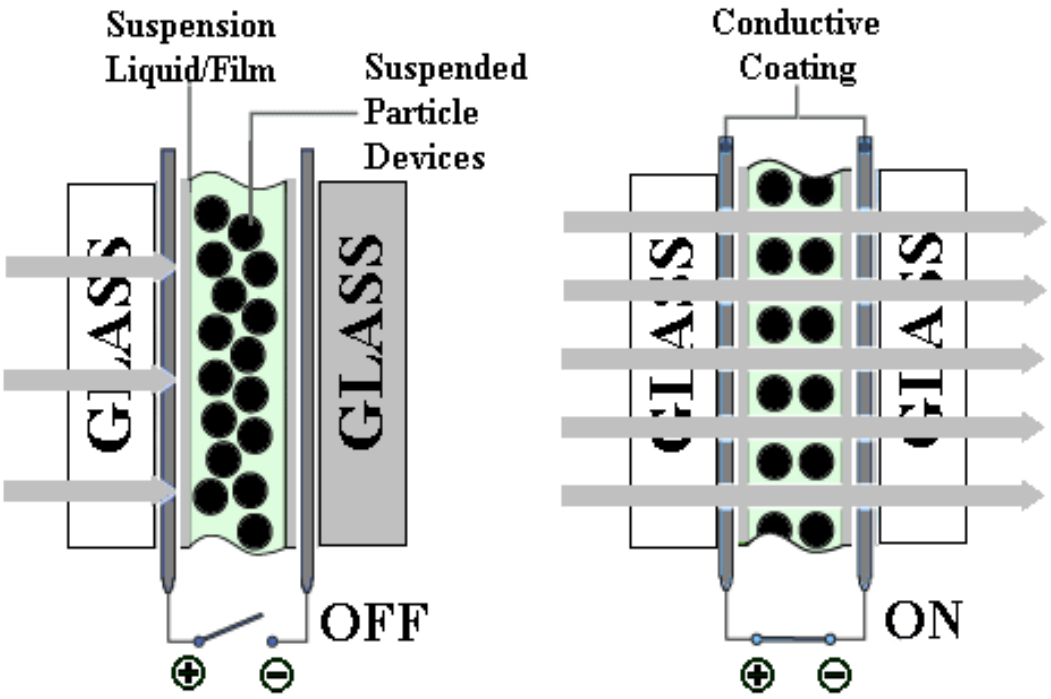

Fig 2: SPD Basic Structure.

Similarly in case of the micro binds (currently under research in National Research Council, Canada), we have rolled metal binds deposited over a transparent insulator layer by the process of magnetron sputtering and patterned by lithography. All this is substrated over a Transparent Conductive oxide (TCO). When no voltage is applied light passes normally. As we apply some voltage the rolls tend to align and hinder the light flow. Thus changing the transparency of the glass. We can even change the color of glass depending upon the applied voltage and material embedded into the glass. This helps in UV protection in sunlight, eye protection during computer usage and IR blocking during a sunny day.

Nano crystal of Indium Tin Oxide (In_2O_5Sn) when embedded into the glassy matrix of Niobium Oxide (NbO_X) can be used as one of the layers in our glass to create an electrically excitable UV protection glass. Tungsten Doped Vanadium Dioxide (VO2) can act as an IR filter layer. Embedding the transition metal hydrides into the glass matrix results in the formation of an electrically color varying glass that can block UV without affecting the visibility of the glass. All these glasses don't affect the visibility or any other properties other than as discussed.

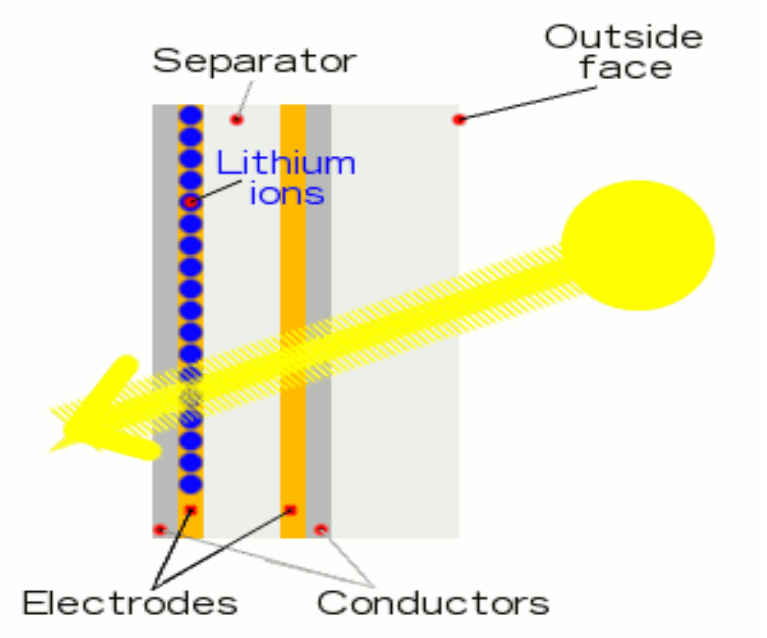

Fig 3: Basic structure.

Thus we can have a single substrate glass that can be a converging lens or a diverging lens along with different layers discussed grown on it connected to some voltage source to excite them to create a multi-functional glass.

For our GlassXx© we have chosen a converging lens with an IR filter layer, followed by a color varying transition metal hydride layer, and with the end layer of electro-chromic reflectors. Thus we have a converging glass lens, sun-block glasses, anti-glare glasses and an IR block glasses in a single substrate.

3. CONTROL INPUTS

The intelligence of the The GlassXx© lies in the control mechanism. The multi utility of the GlassXx© is dependent on the inputs that control it. The inputs from the brain wave sensors and light intensity sensors are the two inputs.

i. A brain wave sensor:

Fig 4: A brain wave sensor.

A brain sensor is an electronic device that can record the electrical activity associated with and mental or physical task of the body. The brain sensor is Electroencephalography (EEG) equipment combined with Brain-Computer Interfaces (BCI) is a driving force for utilizing electroencephalography technology (EEG), which is the process of recording brain activity from the scalp using electrodes. It is found that different electrical frequencies could be linked to actions and different stages of consciousness. This was done by observing subjects performing different tasks, like solving mathematical problems, while recording their EEG most used frequency bands, and their relations, of the human brain wave activity.

Gamma waves:

Gamma waves are in the frequency range of 31Hz and up. It is thought that it reflects the mechanism of consciousness. Beta and gamma waves together have been associated with attention, perception, and cognition (Rangaswamy et al., 2002).

Beta waves:

Beta waves are in the frequency range of 12 and 30 Hz, but are often divided to get a more specific range. The waves are small and fast, associated with focused concentration and best defined in central and frontal areas. When resisting or suppressing movement, or solving a math task, there is an increase of beta activity (Y. Zhang, Chen, Bressler, & Ding, 2009). In one study by Ra gaswamy et al. (2002), significantly increased beta power was found in all of the 307 alcohol-dependent subjects, measured across the whole scalp. This leads to an hyper excitable state which consumption of alcohol temporarily alleviates.

Alpha waves:

Alpha waves, ranging from 7.5 to 12 Hz, are slower and associated with relaxation and disengagement. Thinking of something peaceful with eyes closed should give an increase of alpha activity, most profound in the back of the head and in the frontal lobe. Several studies have found a significantly rise in alpha power after smoking marijuana (Lukas, Mendelson, & Benedict, 1995).

Theta waves:

Theta waves, ranging from 3.5 to 7.5 Hz, are linked to inefficiency, Day dreaming, and the very lowest waves of theta represent the fine line between being awake or in a sleep state. Theta arises from emotional stress, especially frustration or disappointment (L. Zhang, He, Miao, & Yang, 2005). It has also been associated with access to unconscious material, creative inspiration and deep meditation. High levels of theta are considered abnormal in adults, and is for instance, much related to AD/HD (Heinrich, Gevensleven, & Strehl, 2007).

Delta wave:

Delta waves, ranging from 0.5 to 3.5 Hz, are the slowest waves and occurs when sleeping (Hammond, 2006). If these waves occur in the awake state, it thought to indicate physical defects in the brain. Movement can make artificial delta waves, but with an instant analysis (just observing raw EEG records), this can be verified or unconfirmed. MU is associated with motor activities, and is also found in the alpha wave frequency range, but where the maximum amplitude is recorded over motor cortex. So it basically triggers when there is an actual movement or there is an intent to move (Bernier, Dawson, Webb, & Murias, 2007).

All these wave-groups occur in different parts of the brain in varying degree.

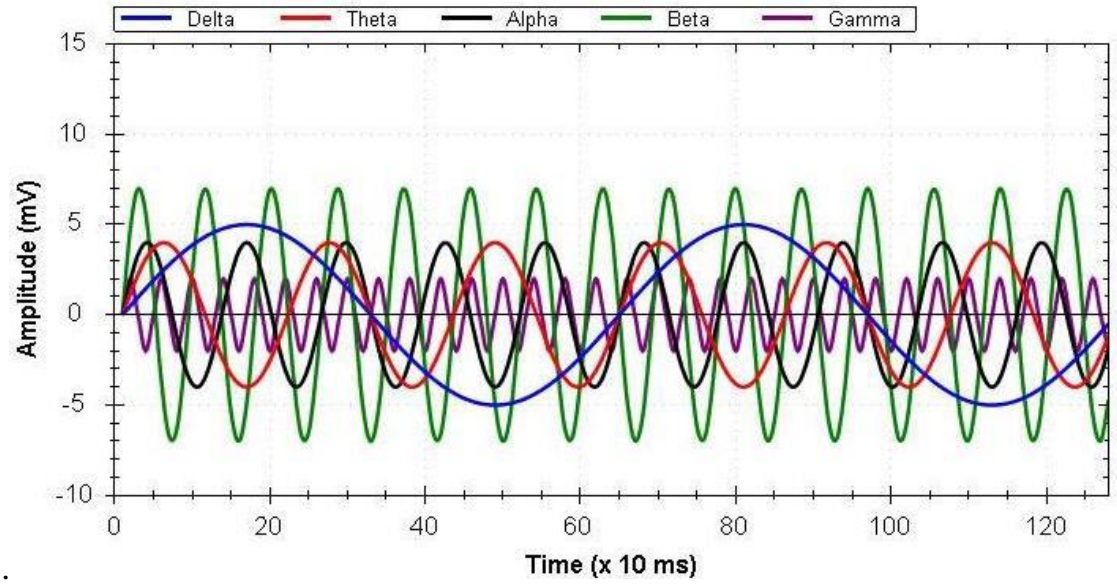

Fig 5: The 5 main frequency bands and their relation to each other.

In order to get general information about the user's brain wave pattern, the user must execute a series of mental task scenarios. This information will then be used to train a classification system so it can learn to recognize and thus map different brain patterns to actions. In the developmental phase of the product we need to analyze the brain waves of the people when they feel a need to use sunshades, when their eyes are etching looking into the screen continuously, when there is a bit dark to see or when he feels to change the color of his glasses. Repeating the analysis over a series of subjects will help us create a very specific BRAIN LIBRARY, which can be used take decisions by the BCI attached to the design.

ii. Light intensity sensor:

A light intensity sensor is an additional feature in our design of the GlassXx. It keeps track of the environmental condition i.e. the light intensity. When the intensity is high, low or medium it sends the data to the embedded processor to complete the control input data.

The GlassXx© is completed when we combine the glass, Brain Sensor, BCI, LIS and the thermocouples. It is worn like a normal glass. The brain sensor is connected to the forehead and powered by the body heat. It keeps track of the brain waves along with the LIS that give this input to the BCI. Depending upon the input the BCI sends a signal to the connected glass layer to change its property electrically. Be it color change, translucence change, activating the night vision layer or anything else.

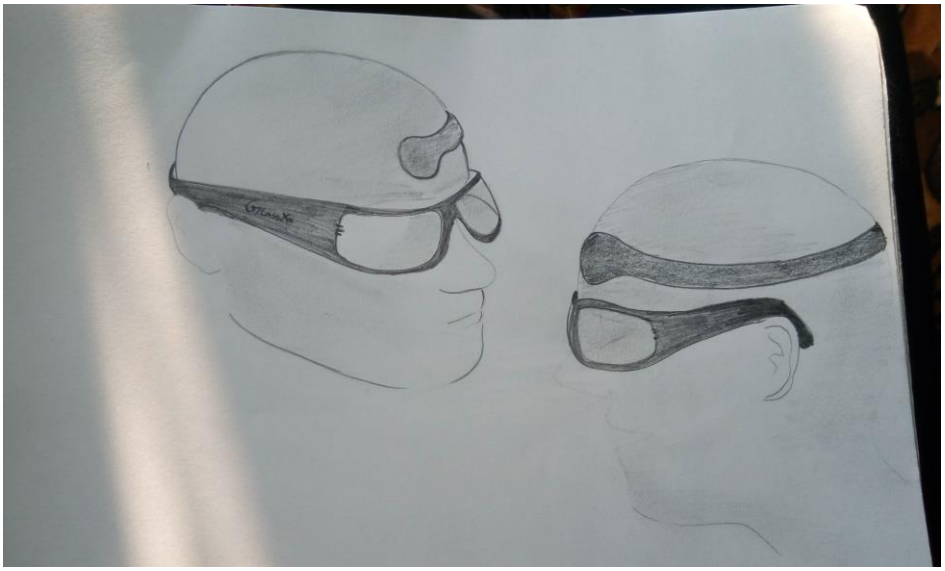

Fig 6: The Design

We can add mini solar cells to add to the thermo couples for power in the future edition. Thickness varying lens will be handy addition to allow the lens to change the type from myopic to hyper metopic by a signal burst other than all these possible features we discussed. We can include some more sensors to allow a more practical change in the lens properties. This would be a revolutionary product with such features.

4. CONCLUSIONS

The research idea of the GlassXx© is a novel one. In this paper, we have tried to discuss the possibilities with the development GlassXx© as wearable technology. We have tried to outline whether and how the technology will develop and how fast it might become mainstream. The design we have presented can be further modified to make it efficient in terms of power usage, power generation, design and accessorial fashion. The in-depth design of the BCI has not been discussed because of the wide range of design choices available. The extensive research in the field of wearables has advanced the minutarisation, which is helpful for the design. This glass can serve as the basis for upgrading the google glasses to allow all these features along with the google glass technology.

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