RAY-BAN GLASSES

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Abstract. Will be briefly shown how *Ray-Ban* glasses can protect the human eyes from the solar ultra violet radiation.

(1)Introduction.

In **Section 1**is shown the Solar Radiation Spectrum being partially absorbed when it passes by the atmosphere. In **Section 2** are analyzed malefic effects of the ultraviolet radiation on the human eyes. In **Section 3** see how these effects can be avoided using *Ray-Ban* glasses. .

(2)The Solar Radiation Spectrum.

In **Figure 1**[1] is seen the light spectrum at the top of the Earth's atmosphere and at sea level. The sun emits light frequencies with a distribution similar to that of a blackbody.[2] at 5525 K (5250 °C) which is approximately the sun's surface temperature. As light passes through the atmosphere, it is partially absorbed by gases with specific absorption bands. These curves[1] are based on data for above the atmosphere and at sea level. Regions for ultraviolet,visible and infrared light are indicated.

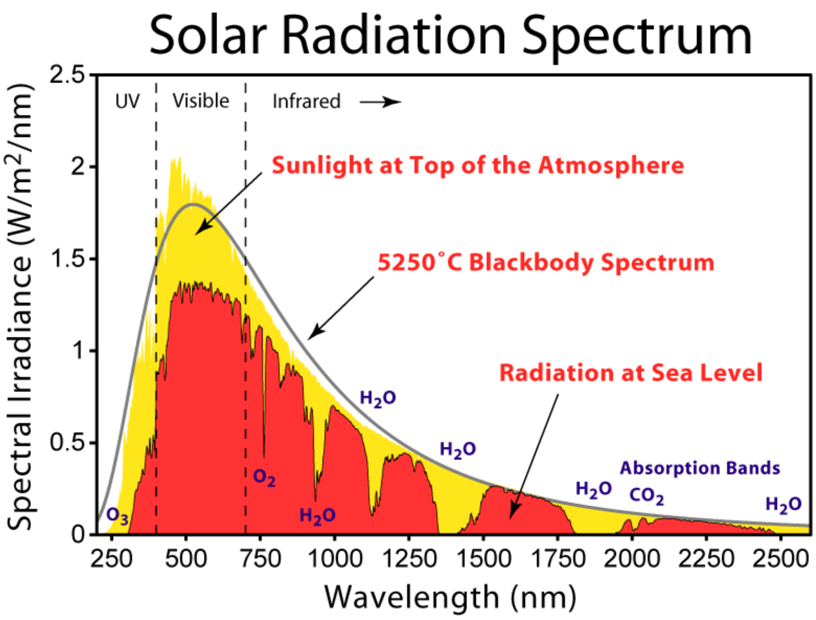

Figure 1. Solar Radiation Spectrum.[1]

As well known,[3] exposure of our body to radiation from sunlight presents both positive and negative health effects. However, here we intend only to analyze the UV effects on the eyes.

(3) UV Effects on the Eyes.

The ultraviolet light exposure to the eye has been associated**[3]** with **cataract formation and retinal degeneration**. In both cases, it is hypothesized that ultraviolet light can initiate formation of free radicals, which can cause protein modification and lipid peroxidation.

To help prevent retina damage that is linked to ultraviolet rays, patients are encouraged to wear sunglasses to protect against UVA and UVB rays. Many years ago, in 1936, was created by the Bausch & Lomb the Ray-Ban[5] glasses which name was hence derived from the ability of these glasses to limit the ingress of either UV or infra-red rays of light. Photos of Ray-Ban glasses can be seen, for instance, in reference [5].

Modern sunglasses have **photochromic lenses**[4] that darkens on exposure to light of sufficiently high frequencies, most commonly ultraviolet (UV) radiation. These lenses are made of **photochromic glass** or **plastic**. In absence of activation light, these return to their clear state.

(a)Photochromic glass lenses are embedded of microcrystalline silver halides(usually *sliver chloride*). Which in the presence of UV light, with frequencies of 320-400 nm, electrons from the glass combine with *colourless silver cations* to form elemental silver, that is,

$$AgCl \;+\; e^{-} \;\leftrightarrow\; Ag \;+ Cl^{-} \qquad\qquad ;$$

as the elemental silver is visible, the lenses appear darker. In the shade this reaction is reversed. With the photochromic material dispersed in the glass substrate, the degree of darkening depends on the glass thickness.

(b)Photochromic plastic lenses (with another sort of technology) are composed by organic photochromic molecules. These, when exposed to UV rays as in direct sunlight, undergo a structural change which absorbs a significant percentage of the visible light, i.e., *they darken.* They are also composed by substances to achieve the reversible darkening effect. These lenses darken only when exposed to the intense sun light, but not to an artificial light. With plastic lenses the material is typically embedded into the surface layer of the plastic in a uniform thickness of up to 150 μm.

(4) UV radiation.

UV radiation is divided into 3 wavelength ranges called **UV-A, UV-B** and **UV-C.** The **UV-A** range is between 400 and 315 nm (is the typical "black light"). This radiation that can be emitted by fluorescent or LED lamps in this wavelength range. The **UV-B** range is between 315 and 270 nm, and the **UV-C** range is between 270 and 100 nm, also known as "germicidal radiation".

Above the Earth´s atmosphere, solar radiation has the following spectrum, according to **Figure 2.**

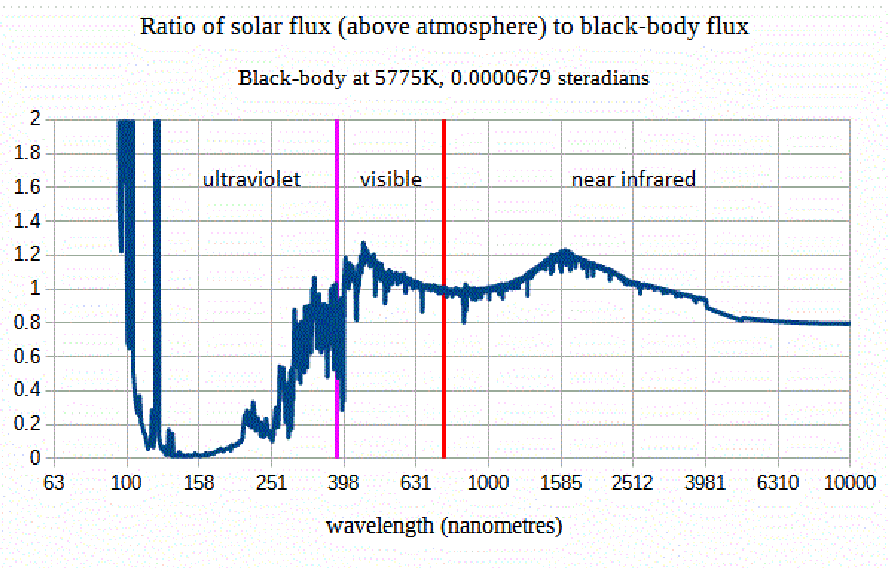

Figure 2. Solar radiation above atmosphere.

From **Fig.2** we can observe peaks of radiation incidence in the **UV-C** range. This radiation interacts especially with oxygen molecules (O_2), which break down, forming a pair of atomic oxygen (O). In turn, atomic oxygen reacts with the oxygen molecule, forming the ozone molecule (O_3), as shown in **Fig.3**,

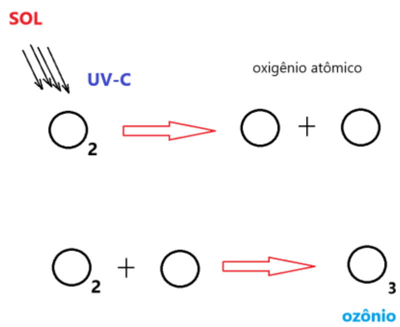

Figure 3. Formation of ozone through **UV-C** radiation.

In this way, practically 100% of **UV-C** radiation is absorbed by the atmosphere and does not reach the Earth´s surface. Ozone gas, produced by **UV-C** radiation, in turn is responsible for absorbing a large part of the radiation in the **UV-B** range, that is, around 95% of the wavelength range from 315 to 270 nm. Thus, only around 5% of **UV-B** radiation reaches the Earth´s surface.

Radiation in the **UV-A** range practically does not interact with the atmosphere and is barely absorbed by it. It is estimated that only around 5% of UV-A radiation is absorbed, that is, around 95% of this radiation reaches the Earth´s surface. Therefore, a large part of the **UV** radiation that reaches our surface is in the **UV-A** range (95%) and little **UV-B** (5%).

(5) Darkening of photochromic lenses.

We show now the darkening of the photochromic lens submitted to ultraviolet LED flashlight and to frequencies in the **UV-A** range. **In Fig.4** are seen glasses with photochromic lenses and a UV-A flashlight.

Figure 4. Photochromic glasses and the UV-A flashlight.

Now, in **Fig.5** is seen the incidence of a flashlight on one of the photochromic lenses for about 10 seconds.

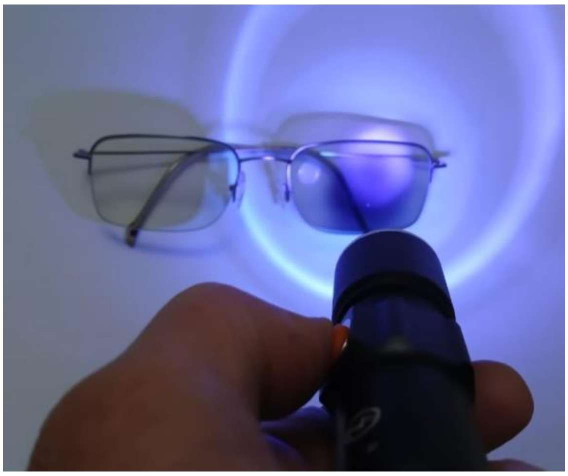

Figure 5. Incidence of a **UV** flashlight on the right lens.

After about 10 seconds, we observe (see **Fig.6)** the darkening of the irradiated photochromic lens.

Figure 6. Right lens darkened after exposure to **UV-A** radiation.

Now let us take two glasses: one similar to used in **Fig.5**, with photochromic lenses, and a dark one ("sun glass") without photochromic lenses(see **Fig.7**).

Figure 7. Glasses with photochromic lenses and another (**dark**) without.

To test the effectiveness of the dark sunglasses in blocking **UV-A** radiation these are placed between the **UV-A** flashlight and the photochromic glasses (see **Fig. 8**). Now, we turn on the flashlight for about 15 seconds.

Figure 8. Dark sunglasses between the flashlight and the photochromic lens.

After the applied radiation, we noticed that the photochromic lens becomes darkened (see **Fig.9)**.This proves that part of **UV-A** radiation passed thought the dark lenses, demonstrating the ineffectiveness of these lenses in blocking **UV-A** radiation.

Figure 9. We observe that Photochromic lens becomes darkened by radiation that passed through the sunglasses.

This test proves the importance of **UV** protection, especially when using poor quality sunglasses. Since UV is an invisible, sunglasses without **UV** protection can give us the false impression that our eyes are protected, which can actually cause damage to our vision.[3-5]

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