Protection from UV radiation

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Annotation

Are expensive glasses with UV filter a better protection than cheap glasses? And what is the case with sun-lotions? In this article we aim to present the results of our two-year experimenting.

Introduction

In this day and age humankind does strongly harm the ozone layer that is the natural protection of our planet from UV radiation. The arising holes in the ozone layer are the cause for more and more actual need for sufficient protection from UV radiation. For this reason we decided to verify the functionality of commonly available protective tools such as sun-lotions of different protective factors, sunglasses (expensive and cheap) and dioptric glasses. For curiosity we even tried the homemade sun-lotion according to an internet-available manual.

Theory

The UV radiation is an electromagnetic radiation with shorter wavelengths than the visible light, but longer than X-rays. According to wavelengths we differentiate three types: UVA (400-320 nm), UVB (320-280 nm) and UVC (bellow 280 nm). The ozone layer lets through approximately 30 % of UVA radiation to the Earth surface. This causes aging of skin and it also can contribute to skin cancer. Only 1 % of UVB radiation is let through to the surface by the ozone layer. This radiation, however, is malignant and directly causes skin cancer. The UVC radiation is the most harmful, but fortunately it hardly impacts us at all. For the description we will mostly use physical quantity transmittance. It is defined as a rate of radiation intensity that goes through the studied sample over the total impacting intensity.

Original work

At first we were not very familiar with UV radiation and therefore we studied primarily the theory of this issue. Our school lent us a measuring kit

Vernier (LabQuest2+Vernier UVB sensor) and an x-ray tube with wide spectrum that is commonly available in local stores with light bulbs. We bootstrapped a measuring apparatus that was composed of tube isolating the apparatus from its surroundings, caps on both sides of the tube and a stand. We put a sensor on one side of the apparatus and a UV discharge tube on the other side. You can see the apparatus and blueprint of its function in fig. 1. We measured the transmittance of different dioptric glasses and various sunglasses. Furthermore, we also tested sun-lotions. We tried to create an uninterrupted layer of lotion on the underlaying glass, but we did not manage to succeed. Therefore we tried to put the lotion on chicken skin. The precision of this method, however, is disputable. For more experiments our bustled apparatus was not sufficient anymore so we agreed to get in touch with the University of Pardubice for further collaboration.

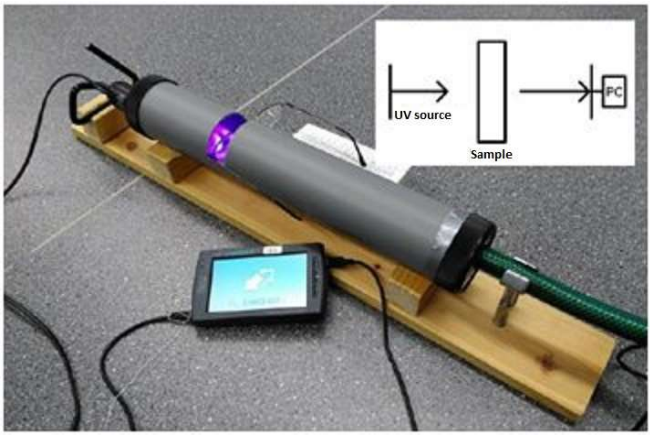


Fig. 1

Current work

Together with Ing. Petr Kutálek we agreed to begin the current research with the Joint Laboratory of Solid State Chemistry at the University of Pardubice. For all our measurements we used the spectrophotometer Perkin Elmer UV-Vis Lambda 12 that was available in our workplace. You can see the scheme of this tool in fig. 2. It compares permeability of the reference sample (for example UV cell with isopropyl alcohol) and the researched sample (for example UV cell with the solution of isopropyl alcohol and sun-lotion). Therefore the resulting transmittance is the ratio of the intensity of radiation

that passes through the sample over the intensity of radiation that passes through the reference sample.

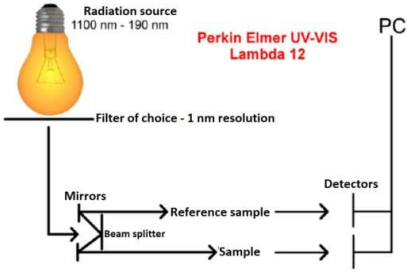


Fig. 2

Dioptric glasses

First of all we studied dioptric glasses. In total we measured 10 dioptric glasses of different age, brands, lens powers and also types of lenses. They differed in price (sometimes the difference of several thousands of Czech Crowns) and also whether they had a UV filter. We borrowed glasses from relatives. You can see the results of measurements in fig. 3. All dioptric glasses with UV filter had almost zero transmittance in the UV interval, which was independent on their price. Glasses without UV filter let through about 20 % of the UV radiation, which is an interesting result proving that even regular glass or plastic can protect us. In conclusion dioptric glasses without UV filter grant us very good protection and glasses with UV filter guarantee almost 100% protection that is invariant to their price.

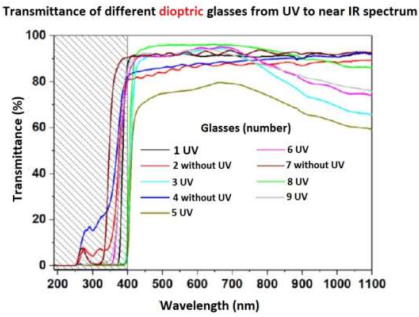


Fig. 3

Sunglasses

We often hear that you should not save money on sunglasses or that sunglasses from Asian street markets provide insufficient protection from the UV. We decided to test this hypothesis. We had 8 samples in total, among them both the expensive and cheap ones from market. But there is still one more problem. Should the sunglasses let the UV through, it would have a worse impact than dioptric glasses. It is because sunglasses capture a portion of visible light, the pupil dilates to compensate this and therefore receives more UV. For that reason the quality of sunglasses is truly key. The results are again interesting (fig. 4). It is clear that all the glasses passed the test with flying colours. We believe that the result is caused by the thing that all the glasses (either cheap or expensive) are fabricated from a specific type of polymer that itself has the property of capturing the UV radiation. That is the reason why it does not matter how costly glasses we buy. They protect us all the same against the UV. But of course we choose glasses according to different aspects as well.

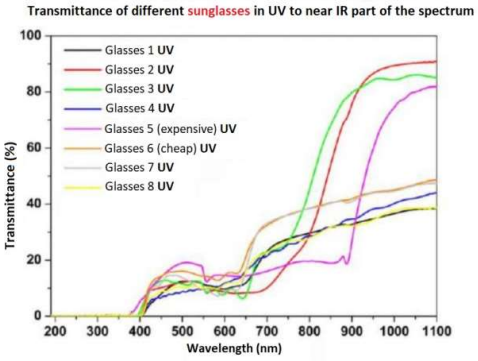


Fig. 4

Sun-lotion – different concentrations

The eye is not the only thing at risk, but also the skin. Frequent exposure of skin to UV radiation can increase the risk of skin cancer. For that reason we tested sun-lotion. We chose sun-lotions of several brands and factors (Astrid 15, Ladival 30 and 50, Helios 20, Avon 10) and put them all to testing. First we tried to spread a homogenous layer of sun-lotion between two SiO_2 cover slips (they let the UV rays through). This method was not entirely great from the

point of reproducibility, so we decided to continue with our second method. We were dissolving backfills of sun-lotion in 10 ml of isopropyl alcohol (especially for small amounts of sun-lotion it is then necessary to consider the measurement as only an approximation neglecting the properties of skin). First of all we measured an upward sequence of concentrations for different sun-lotion. Concretely in fig. 5 there is sunscreen Avon (factor 10). It can be seen that even a small concentration protects well against the UV rays and that using sun-lotion makes sense as it provides quality protection.

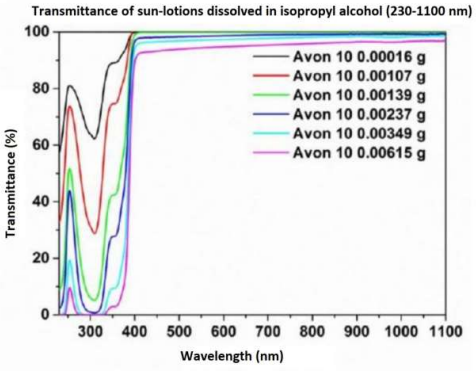


Fig. 5

Sunscreen – different lotions

Furthermore we compared lotions of different factors and brands. We can see the results in fig. 6. Here it is more practical to compare absorbances. Absorbance is defined as the minus logarithm of transmittace. It is therefore a logarithmic scale so the bigger the absorbance is, the smaller the permeated radiation that the lotion lets through will be. All the lotions were measured with the same concentration. There is a visible difference between particular lotions. We can also see that all the lotions have very similar absorptive bands. From this we infer that used protective constituents in all the lotions are very similar and therefore the lotions of different brands do not differ very much in used ingredients.

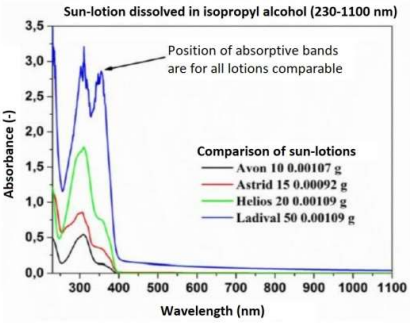


Fig. 6

Sun-lotion – homemade

Internet is full of various guides on how to make homemade sunscreen that should be healthier, cheaper, and mainly as effective as industry-standard sunscreen. So we decided to make one such lotion and test it the same way as the previous lotions from a store. We dispersed macroparticles of zinc oxide into coconut oil. In lotions of industry-standardised quality the nanoparticles of ZnO are used. They are on one hand more efficient, but on the other they have negative health-related effects. For this reason we tried to fabricate a lotion composed from macroparticles. Under constant stirring we let the resulting suspension solidify in cold water. The advantage of solid lotion is that it is easy to apply on skin. We prepared several different concentrations. We found out that coconut oil does absorb almost no UV radiation and that it functions only as a solvent (fig. 7).

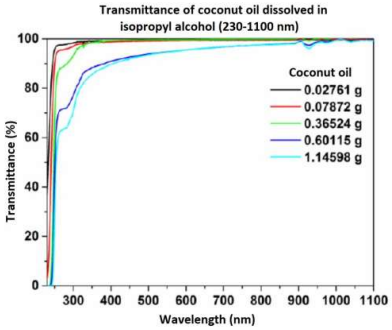
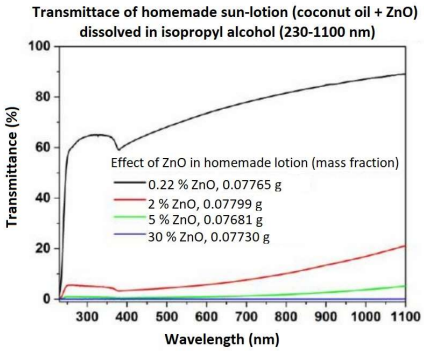


Fig. 7

In fig. 8 we can see transmittances of our homemade lotions with different concentration of ZnO. For comparison we included one industry-standard lotion. We observe that homemade lotion can compete in efficiency with the industry-standard, but under the condition of higher concentration of ZnO. There is, however, an uncertainty in our conclusion, because we could not measure the lotion when applied on human skin and therefore dismiss any dwindling in efficiency that could be caused by the characteristics of human skin.



Obr. 8

Conclusion

Dioptric glasses with UV filter grant us an excellent protection from UV radiation, dioptric glasses without UV filter grant us protection that is good. Sunglasses will provide us with excellent protection regardless of price or presence of UV filter. Sun-lotions give very good protection. There is a substantial difference between lotions of differing factors, higher factor lotions absorb appreciably more UV radiation. Our natural homemade sun-lotion is in efficiency comparable to the industry-standard ones, it however necessary to apply it in higher quantities (we did not use nanoparticles). This result is however burdened with uncertainty since its efficiency can be influenced by the characteristics of the skin or other factors.