First Latin-American Congress
on Solid State Dosimetry and Radiation Measurements
13-17 September, 2021

PERSONAL MONITORING OF CUTANEOUS VITAMIN D3 PRODUCTION USING SMARTPHONE THROUGH PRINTABLE UV MOLECULAR DOSIMETRY STRIPS

VAZ, E.C.R.[1], DOMINGUES, T.A.L.[2], SANTOS, T.E.C [2], MOURA, L.A.[2], TAVARES, T.[2], MELO, L.F.M.M.[2], MELO, S.B.[2], and SANTA-CRUZ, P.A.[1]

[1]Departamento de Química Fundamental, Universidade Federal de Pernambuco, 50740-540 Recife, PE, Brazil
[2]Centro de Informática, Universidade Federal de Pernambuco, 50740-560 Recife, PE, Brazil, [1]elaine.vaz@ufpe.br

Introduction: Exposure to the sun allows the skin to generate more than 90% of the vitamin D needed by the human body, and after the current COVID-19 pandemic scenario, in which populations needed to avoid exposure to reduce contamination, it will be necessary to restore the levels of this vitamin, which also plays an important role in the immune system. Cutaneous vitamin D production may be better than oral ingestion, and it can be monitored by UV radiation dosimetry. Twenty years ago, at the 13th International Conference on Solid State Dosimetry (SSD 2001, Athens, Greece), our LandFoton Research Group presented the very first molecular nanodevice for ultraviolet personal dosimetry: "UV Personal Dosimeters of Lanthanide Complex Films: A New Molecular Photonic Device", and in 2014, at the 17th edition (SSD 2013, Recife, Brazil) the Group presented the work "Luminescence Enhancement by Gamma Irradiation of Nanocomposites for UV Dosimetry". The personal dosimeter were produced by PVD of a lanthanide complex designed to act as a molecular device. Recently, a printable version of this UV personal dosimeter[1] allowed scaling, and the patent for this printable device was issued this year[2], after being submitted more than ten years ago. In the present work, thanks to a project approved in the Brazilian SibratecNano Program, we present the first results of a solution that uses smartphones to monitor the personal cutaneous vitamin D production status through a correlation with the received ultraviolet dose using printable strips.

Material and method: The only part of the solar spectrum that causes vitamin D formation is the UVB (280–315 nm), which on reaching the skin, photoisomerizes 7-dehydrocholesterol (7-DHC) to form pre-cholecalciferol, which is isomerized into cholecalciferol (vitamin D3). To monitor the UVB dose for correlation with vitamin D3 production, the photonic molecular device was used to produce an input signal for calculations in a software developed here to run on a smartphone.

The $Eu(btfa)_3 \cdot bipy$ molecular dosimeter, designed and prepared as reported elsewhere, was prepared to be printed as a functional ink by a Drop-on-Demand Materials Printer, to produce functional paper strips. The btfa ligands act as a UV antenna, and the bipy ligand shields the Eu^{3+} ions that produce a red luminescence at 612 nm, inversely proportional to the accumulated UV dose, by a photocleavage mechanism that mimics skin damage, with a memory effect that allows dosimetry.

Results: The generated photonic signal is used as the input in the application (fig. 1) that is being developed to estimate, in a smart way, the amount of vitamin D produced by the user, combining this signal with user inputs (such as clothing coverage, age, etc.), allowing a correlation between UVB dose and the vitamin D3 production. The UV dose obtained by the photonic signal is converted in vitamin D3 dose through a correlation curve like, as an starting example, the one in literature: Y = 3.5X + 14.3, X= UV-B dose (SED); Y= 25(OH)D increased, since in the printed targets reported previously[1], we have observed a range wide enough, up to 1000 times the MED-UVB, for~70% of luminescence quenching, showing, at the same time, high resolution around MED values.

Figure 1: Smartphone App for personal monitoring.

Conclusions: There is a promising solution to personal monitoring of vitamin D production by printable UV dosimeter targets. The screenshot shows daily information, the percentage attained for the vitamin D goal that was medically prescribed in a safer way (in dark blue), and the percentage of exposed skin (in orange).

References:

1. F.L.N. Sousa *et al. Mater. Res. Express* **3** 045701 (2016).
2. P.A. Santa-Cruz, Pat. PI1003026-3. 06 ago. 2010.