ISBN 978-3-902842-34-3

CIE

COMMISSION INTERNATIONALE DE L'ECLAIRAGE
INTERNATIONAL COMMISSION ON ILLUMINATION
INTERNATIONALE BELEUCHTUNGSKOMMISSION

TECHNICAL REPORT

SENSITIVITY OF HUMAN SKIN TO ULTRAVIOLET RADIATION, EXPRESSED AS MINIMAL ERYTHEMA DOSE (MED)

CIE 207:2014

UDC: 612.014.481-06 Descriptor: Optical radiation effects on humans

Documents
Document Sharing Hub

Copyright International Commission on Illumination
Provided by IHS under license with CIE
No reproduction or networking permitted without license from IHS
Full document details: CIE 207-2014

Licensee=Hong Kong Polytechnic University/9976803100, User=ertert, rtet
Not for Resale, 05/10/2015 03:08:06 MDT

THE INTERNATIONAL COMMISSION ON ILLUMINATION

The International Commission on Illumination (CIE) is an organization devoted to international co-operation and exchange of information among its member countries on all matters relating to the art and science of lighting. Its membership consists of the National Committees in about 40 countries.

The objectives of the CIE are:

1. To provide an international forum for the discussion of all matters relating to the science, technology and art in the fields of light and lighting and for the interchange of information in these fields between countries.
2. To develop basic standards and procedures of metrology in the fields of light and lighting.
3. To provide guidance in the application of principles and procedures in the development of international and national standards in the fields of light and lighting.
4. To prepare and publish standards, reports and other publications concerned with all matters relating to the science, technology and art in the fields of light and lighting.
5. To maintain liaison and technical interaction with other international organizations concerned with matters related to the science, technology, standardization and art in the fields of light and lighting.

The work of the CIE is carried on by seven Divisions each with about 20 Technical Committees. This work covers subjects ranging from fundamental matters to all types of lighting applications. The standards and technical reports developed by these international Divisions of the CIE are accepted throughout the world.
A plenary session is held every four years at which the work of the Divisions and Technical Committees is reviewed, reported and plans are made for the future. The CIE is recognized as the authority on all aspects of light and lighting. As such it occupies an important position among international organizations.

LA COMMISSION INTERNATIONALE DE L'ECLAIRAGE

La Commission Internationale de l'Eclairage (CIE) est une organisation qui se donne pour but la coopération internationale et l'échange d'informations entre les Pays membres sur toutes les questions relatives à l'art et à la science de l'éclairage. Elle est composée de Comités Nationaux représentant environ 40 pays.

Les objectifs de la CIE sont:

1. De constituer un centre d'étude international pour toute matière relevant de la science, de la technologie et de l'art de la lumière et de l'éclairage et pour l'échange entre pays d'informations dans ces domaines.
2. D'élaborer des normes et des méthodes de base pour la métrologie dans les domaines de la lumière et de l'éclairage.
3. De donner des directives pour l'application des principes et des méthodes d'élaboration de normes internationales et nationales dans les domaines de la lumière et de l'éclairage.
4. De préparer et publier des normes, rapports et autres textes, concernant toutes matières relatives à la science, la technologie et l'art dans les domaines de la lumière et de l'éclairage.
5. De maintenir une liaison et une collaboration technique avec les autres organisations internationales concernées par des sujets relatifs à la science, la technologie, la normalisation et l'art dans les domaines de la lumière et de l'éclairage.

Les travaux de la CIE sont effectués par 7 Divisions, ayant chacune environ 20 Comités Techniques. Les sujets d'études s'étendent des questions fondamentales, à tous les types d'applications de l'éclairage. Les normes et les rapports techniques élaborés par ces Divisions Internationales de la CIE sont reconnus dans le monde entier.
Tous les quatre ans, une Session plénière passe en revue le travail des Divisions et des Comités Techniques, en fait rapport et établit les projets de travaux pour l'avenir. La CIE est reconnue comme la plus haute autorité en ce qui concerne tous les aspects de la lumière et de l'éclairage. Elle occupe comme telle une position importante parmi les organisations internationales.

DIE INTERNATIONALE BELEUCHTUNGSKOMMISSION

Die Internationale Beleuchtungskommission (CIE) ist eine Organisation, die sich der internationalen Zusammenarbeit und dem Austausch von Informationen zwischen ihren Mitgliedsländern bezüglich der Kunst und Wissenschaft der Lichttechnik widmet. Die Mitgliedschaft besteht aus den Nationalen Komitees in rund 40 Ländern.

Die Ziele der CIE sind:

1. Ein internationaler Mittelpunkt für Diskussionen aller Fragen auf dem Gebiet der Wissenschaft, Technik und Kunst der Lichttechnik und für den Informationsaustausch auf diesen Gebieten zwischen den einzelnen Ländern zu sein.
2. Grundnormen und Verfahren der Messtechnik auf dem Gebiet der Lichttechnik zu entwickeln.
3. Richtlinien für die Anwendung von Prinzipien und Vorgängen in der Entwicklung internationaler und nationaler Normen auf dem Gebiet der Lichttechnik zu erstellen.
4. Normen, Berichte und andere Publikationen zu erstellen und zu veröffentlichen, die alle Fragen auf dem Gebiet der Wissenschaft, Technik und Kunst der Lichttechnik betreffen.
5. Liaison und technische Zusammenarbeit mit anderen internationalen Organisationen zu unterhalten, die mit Fragen der Wissenschaft, Technik, Normung und Kunst auf dem Gebiet der Lichttechnik zu tun haben.

Die Arbeit der CIE wird in 7 Divisionen, jede mit etwa 20 Technischen Komitees, geleistet. Diese Arbeit betrifft Gebiete mit grundlegendem Inhalt bis zu allen Arten der Lichtanwendung. Die Normen und Technischen Berichte, die von diesen international zusammengesetzten Divisionen ausgearbeitet werden, sind auf der ganzen Welt anerkannt.
Alle vier Jahre findet eine Session statt, in der die Arbeiten der Divisionen überprüft, berichtet und neue Pläne für die Zukunft ausgearbeitet werden. Die CIE wird als höchste Autorität für alle Aspekte des Lichtes und der Beleuchtung angesehen. Auf diese Weise unterhält sie eine bedeutende Stellung unter den internationalen Organisationen.

Published by the

COMMISSION INTERNATIONALE DE L'ECLAIRAGE
CIE Central Bureau
Babenbergerstrasse 9, A-1010 Vienna, AUSTRIA
Tel: +43(1)714 31 87
e-mail: ciecb@cie.co.at
WWW: http://www.cie.co.at/

© CIE 2014 - All rights reserved

Documents
Document Sharing Hub

Copyright International Commission on Illumination
Provided by IHS under license with CIE
No reproduction or networking permitted without license from IHS
Full document details: CIE 207-2014

Licensee=Hong Kong Polytechnic University/9976803100, User=ertert, rtet
Not for Resale, 05/10/2015 03:08:06 MDT

ISBN 978-3-902842-34-3

CIE

COMMISSION INTERNATIONALE DE L'ECLAIRAGE
INTERNATIONAL COMMISSION ON ILLUMINATION
INTERNATIONALE BELEUCHTUNGSKOMMISSION

TECHNICAL REPORT

SENSITIVITY OF HUMAN SKIN TO ULTRAVIOLET RADIATION, EXPRESSED AS MINIMAL ERYTHEMA DOSE (MED)

CIE 207:2014

UDC: 612.014.481-06 Descriptor: Optical radiation effects on humans

Documents
Document Sharing Hub

Copyright International Commission on Illumination
Provided by IHS under license with CIE
No reproduction or networking permitted without license from IHS
Full document details: CIE 207-2014

Licensee=Hong Kong Polytechnic University/9976803100, User=ertert, rtet
Not for Resale, 05/10/2015 03:08:06 MDT

This Technical Report has been prepared by CIE Technical Committee 6-48 of Division 6 “Photobiology and Photochemistry" and has been approved by the Board of Administration as well as by Division 6 of the Commission Internationale de l'Eclairage. The document reports on current knowledge and experience within the specific field of light and lighting described, and is intended to be used by the CIE membership and other interested parties. It should be noted, however, that the status of this document is advisory and not mandatory.

Ce rapport technique a été élaboré par le Comité Technique CIE 6-48 de la Division 6 "Photobiologie et Photochimie" et a été approuvé par le Bureau et Division 6 de la Commission Internationale de l'Eclairage. Le document expose les connaissances et l'expérience actuelles dans le domaine particulier de la lumière et de l'éclairage décrit ici. Il est destiné à être utilisé par les membres de la CIE et par tous les intéressés. Il faut cependant noter que ce document est indicatif et non obligatoire.

Dieser Technische Bericht ist vom Technischen Komitee CIE 6-48 der Division 6 "Photobiologie und Photochemie" ausgearbeitet und vom Vorstand sowie Division 6 der Commission Internationale de l'Eclairage gebilligt worden. Das Dokument berichtet über den derzeitigen Stand des Wissens und Erfahrung in dem behandelten Gebiet von Licht und Beleuchtung; es ist zur Verwendung durch CIE-Mitglieder und durch andere Interessierte bestimmt. Es sollte jedoch beachtet werden, dass das Dokument eine Empfehlung und keine Vorschrift ist.

Any mention of organizations or products does not imply endorsement by the CIE. Whilst every care has been taken in the compilation of any lists, up to the time of going to press, these may not be comprehensive.

Toute mention d'organisme ou de produit n'implique pas une préférence de la CIE. Malgré le soin apporté à la compilation de tous les documents jusqu'à la mise sous presse, ce travail ne saurait être exhaustif.

Die Erwähnung von Organisationen oder Erzeugnissen bedeutet keine Billigung durch die CIE. Obgleich große Sorgfalt bei der Erstellung von Verzeichnissen bis zum Zeitpunkt der Drucklegung angewendet wurde, besteht die Möglichkeit, dass diese nicht vollständig sind.

© CIE 2014 - All rights reserved

Documents
Document Sharing Hub
Copyright International Commission on Illumination
Provided by IHS under license with CIE
No reproduction or networking permitted without license from IHS
Full document details: CIE 207-2014
Licensee=Hong Kong Polytechnic University/9976803100, User=ertert, rtet
Not for Resale, 05/10/2015 03:08:06 MDT

The following members of TC 6-48 “Typical Minimal Erythemal Doses“ took part in the preparation of this Technical Report. The committee comes under Division 6 “Photobiology and Photochemistry”.

Authors:

Beer, J.	**USA (Chair) †**
Cesarini, J.-P.	France
Cestari, T.	Brazil
Diffey, B.	United Kingdom
Miller, S.	**USA (Co-Chair)**
van der Leun, J.	Netherlands

Acknowledgements:

The committee expresses special appreciation for contributions to this Technical Report by the TC Chair Janusz Beer, who passed away on October 17, 2013.

The committee would like to acknowledge the efforts of Ms. Gwendolyn Halford, Librarian at the Food and Drug Administration, who performed numerous literature searches and excellent analyses of the published material in support of this Technical Report.

Special thanks go also to S. Coelho (USA), F. de Gruijl (Netherlands), V. Hearing (USA), N. Kollias (USA) and G. Stamatas (France) for their careful review of the document and their useful feedback.

Documents
Document Sharing Hub

Copyright International Commission on Illumination
Provided by IHS under license with CIE
No reproduction or networking permitted without license from IHS
Full document details: CIE 207-2014

Licensee=Hong Kong Polytechnic University/9976803100, User=ertert, rtet
Not for Resale, 05/10/2015 03:08:06 MDT

CONTENTS

Summary V
Résumé V
Zusammenfassung V
Scope 1
1 Introduction 1
2 Terms and Definitions 1
3 Predicting UVR Sensitivity 2
3.1 Predicting Sensitivity to UVR Using Clinical Parameters – Fitzpatrick Phototypes 2
3.2 An Attempt to Relate Skin Typing to Melanogenesis 2
3.3 Predicting Sensitivity to UVR Using Individual Typological Angle (ITA) Derived from Chromametric Measurements of Unexposed Skin 3
4 Measuring UVR Sensitivity 4
4.1 Erythema (Sunburn) Induction and its Time Course 4
4.2 Minimal Erythema Dose (MED) and Minimal Perceptible Erythema Dose (MPED) 4
4.3 Anatomical, Gender and Age-Related Differences in Erythemal Sensitivity 5
4.4 Visual Estimation of Erythema and the Effects of Types and Levels of Illumination and of Temperature 6
4.5 Difficulties in Erythema Evaluation in Dark Skin 6
4.6 Dependency of Human UVR Response on Skin Colour 6
4.6.1 Melanin 7
4.6.2 Race/Ethnicity, Skin Colour and Pigmentation 7
4.7 Colour Comparison Charts 8
4.8 Red-Coloured Optical Filters 8
4.9 Reflectance Spectrophotometry 8
4.10 Computer-Assisted Digital Image Analysis (CADIE) 9
4.11 The Importance of Spectral Analysis and Wavelength Weighting in Quantification and Standardization of Erythemal Response 9
5 Examples of MED Values 11
5.1 MED Distribution by Phototype 11
5.2 MED Distribution by Race/Ethnicity 11
5.3 MED and MPD 12
6 Predicting UVR Sensitivity vs. Measuring UVR Sensitivity 13
7 Proposal for Categorizing UVR Sensitivity of Human Skin by Typical MEDs (T-MEDs) 13
8 The Use of MED and T-MED 14
8.1 MED and T-MED in UVR Therapy 14
8.2 MED and T-MED in Sunscreen Testing 15
8.3 Indoor Tanning 15
8.4 Occupational UVR Exposure 15
8.5 Education 16
9 Concluding Remarks 16
References 17

Documents
Document Sharing Hub
Copyright International Commission on Illumination
Provided by IHS under license with CIE
No reproduction or networking permitted without license from IHS
Full document details: CIE 207-2014
Licensee=Hong Kong Polytechnic University/9976803100, User=ertert, rtet
Not for Resale, 05/10/2015 03:08:06 MDT

SENSITIVITY OF HUMAN SKIN TO ULTRAVIOLET RADIATION, EXPRESSED AS MINIMAL ERYTHEMA DOSE (MED)

Summary

Sensitivity of human skin to ultraviolet radiation (UVR) varies dramatically depending on its colour and also varies within each colour band. Yet, public health policies regarding UVR exposure of human skin are mostly based on our knowledge of the UVR effects in only one skin type class: fair-skinned White Caucasians. This report gives a review of the different approaches to predicting and measuring UVR sensitivity using the Minimal Erythema Dose (MED). The MED is defined as the smallest amount of radiation that causes a noticeable reddening of the skin in an individual after a single exposure (evaluated 1 day post-exposure). Ultraviolet radiation is used to diagnose and treat skin conditions in patients with a broad range of complexions (skin colour) from very fair to very dark. Occupational UVR exposures also concern workers representing all types of skin. A sizable proportion of the population in Western countries uses UVR-emitting indoor tanning equipment. Environmental UVR can induce damage in human skin of all complexions. This report recommends a new and simplified approach for categorization of human skin, based on their predisposition to sunburn (UVR-induced erythema). This categorization scheme is expected to facilitate modernization of public health policies.

SENSIBILITÉ DE LA PEAU HUMAINE AU RAYONNEMENT ULTRAVIOLET, EXPRIMÉ EN QUALITÉ DE DOSE ERYTHÉMALE MINIMALE (DEM)

Resume

La sensibilité de la peau humaine au rayonnement ultraviolet (UV) varie énormément selon la couleur de la peau et, également, en fonction des bandes spectrales du rayonnement UV. Ainsi, les recommandations de santé publique concernant l'exposition aux UV de la peau humaine sont basées essentiellement sur nos connaissances des effets du rayonnement UV sur un seul type de peau: les blancs caucasiens à peau claire. Ce rapport propose une revue de différentes méthodes pour prédire et mesurer la sensibilité UV individuelle en utilisant la Dose Erythémale Minimale (DEM). La DEM est définie comme la plus petite quantité de rayonnement qui déclenche une rougeur décelable de la peau chez un individu après une seule exposition (évaluation pratiquée 24 heures après l'exposition). Le rayonnement ultraviolet est utilisé pour diagnostiquer et traiter certaines conditions cutanées chez des patients présentant une large gamme de teints (couleur de la peau) de très clair à très sombre. Les expositions à l'UV, dans le cadre du travail, concernent également des travailleurs présentant tous les types de peau. Une proportion notable de la population des pays occidentaux utilise des équipements émettant des UV pour bronzer en intérieur. Le rayonnement UV environnemental peut induire des lésions dans la peau humaine de toutes les couleurs. Ce rapport recommande une méthode nouvelle et simplifiée pour classer la peau humaine, méthode basée sur la prédisposition au coup de soleil (érythème induit par l'UV). Ce schéma catégoriel devrait faciliter la mise en œuvre moderne des directives de santé publique.

EMPFINDLICHKEIT DER MENSCHLICHEN HAUT HINSICHTLICH UV-STRAHLUNG, AUSGEDRÜCKT ALS MINIMALE ERYTHEMDOSIS (MED)

Zusammenfassung

Die Empfindlichkeit der menschlichen Haut hinsichtlich ultravioletter (UV-) Strahlung ist erheblich von ihrer Farbe abhängig und variiert ebenfalls innerhalb jedes Farbbandes. Dessen ungeachtet sind öffentliche Gesundheitsrichtlinien zur UV-Bestrahlung menschlicher Haut meistens auf der Kenntnis der UV-Effekte in lediglich einer Hauttypklasse basierend, nämlich der der „Hellhäutigen Weißen Kaukasier". Dieser Bericht gibt einen Überblick über die verschiedenen Ansätze, UV-Empfindlichkeit bei Nutzung der Minimalen Erythemdosis (MED)

Documents
Document Sharing Hub

Copyright International Commission on Illumination
Provided by IHS under license with CIE
No reproduction or networking permitted without license from IHS
Full document details: CIE 207-2014

Licensee=Hong Kong Polytechnic University/9976803100, User=ertert, rtet
Not for Resale, 05/10/2015 03:08:06 MDT

vorherzusagen und zu messen. Die MED ist definiert als kleinste Strahlungsmenge, welche eine erkennbare Rötung der Haut bei einer Person nach einmaliger Strahlungsaussetzung hervorruft (bewertet einen Tag nach der Bestrahlung). UV-Strahlung wird zur Diagnose und Behandlung von Hautzuständen bei Patienten mit einer großen Bandbreite der Hautfarbe von hell bis sehr dunkel eingesetzt. Berufliche UV-Aussetzung betrifft ebenfalls Arbeiter aller Hauttypen. Ein erheblicher Anteil der Bevölkerung in westlichen Ländern nutzt UV-Bräunungsgeräte. In der Umwelt vorhandene UV-Strahlung verursacht Schäden in menschlicher Haut jeglicher Hautfarbe. Dieser Bericht empfiehlt einen neuen und vereinfachten Ansatz zur Kategorisierung von Menschen, basierend auf ihrer Veranlagung zu Sonnenbrand (UV-induziertes Erythem). Dieses Kategorisierungsschema soll eine Überarbeitung öffentlicher Gesundheitsrichtlinien unterstützen.

Documents
Document Sharing Hub
Copyright International Commission on Illumination
Provided by IHS under license with CIE
No reproduction or networking permitted without license from IHS
Full document details: CIE 207-2014
Licensee=Hong Kong Polytechnic University/9976803100, User=ertert, rtet
Not for Resale, 05/10/2015 03:08:06 MDT

Scope

This Technical Report deals with differences in ultraviolet radiation (UVR) sensitivity among humans and its established or postulated relations to skin colour, complexion, melanin content and race/ethnicity. Particular attention is given to predicting and measuring UVR sensitivity in terms of Minimal Erythema Doses (MEDs). Examples of MED values measured in different medical research centres are provided. Prediction of UVR sensitivity is compared with the results of actual measured sensitivity. This report recommends a new and simplified approach for categorization of humans, based on their predisposition to sunburn (UVR-induced erythema). Typical MEDs for the different categories are proposed. Finally, the report provides suggestions and recommendations for diversification of public health policies based on the proposed simplified categorization system.

1 Introduction

Sensitivity of human skin to UVR varies dramatically depending on skin type and other factors. Yet, public health policies regarding UVR exposure of human skin are mostly based on our knowledge of the UVR effects in only one skin type class: White Caucasians. Examples of documents that deal with human UVR sensitivity are the International Electrotechnical Committee (IEC) Standard for UVR-emitting Appliances (International Electrotechnical Commission 2009), the Performance Standard for Sunlamp Products of the U.S. Food and Drug Administration (Food & Drug Administration 1985), the International Commission on Non-ionizing Radiation Protection (ICNIRP) guidelines (ICNIRP 2004) and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists (ACGIH) (ACGIH 2011).

UVR is used to diagnose and treat skin conditions in patients with a broad range of complexions from very fair to very dark. Occupational UVR exposures also concern workers representing all types of skin. A sizable proportion of the population in Western countries uses UVR-emitting indoor tanning equipment. Environmental as well as artificial UVR induces damage in human skin of all possible complexions. Different measures are taken by lawmakers and governments to prevent skin damage from UVR. Consumers use clothing or sunscreens in an attempt to reduce the damage. One of the end points in testing the efficacy of sunscreens is UVR-induced erythema.

The most commonly used measure of UVR sensitivity is Minimal Erythema Dose (MED), i.e. the smallest amount of radiation that causes a noticeable reddening of the skin from a single UVR exposure (see definitions). The perception of redness by the human eye depends on the combination of melanin dispersion and vasodilatation in the epidermis and on the quality of the incident light. Different studies showed that 1 MED can cause gene and protein expression alterations (Tadokoro et al. 2003; Seite et al. 2004; Young et al. 1998). MED shows poor correlation with skin colour or race/ethnicity, and correlations between erythemal response and DNA damage are complex (Tock et al. 2011; Young et al. 1998). Other phenotype characteristics that may correlate with the susceptibility to sunburn are hair colour, eye colour and freckles (Andreassi et al. 1987; Azizi et al. 1988). This document will concentrate on UVR sensitivity of the skin (i.e. not the eye).

2 Terms and Definitions

For the purposes of this document, the terms and definitions given in the International Lighting Vocabulary (CIE 2011a) and the following apply.

2.1
minimal perceptible erythema dose (MPED)
smallest amount of UVR that causes a just perceptible reddening of the skin, usually observed 24 h post-exposure

Documents
Document Sharing Hub
Copyright International Commission on Illumination
Provided by IHS under license with CIE
No reproduction or networking permitted without license from IHS
Full document details: CIE 207-2014
Licensee=Hong Kong Polytechnic University/9976803100, User=ertert, rtet
Not for Resale, 05/10/2015 03:08:06 MDT

2.2
minimal pigmentation dose (MPD)
smallest amount of UVR producing a just perceptible tan (pigmentation) that can be seen approximately one week post-exposure

2.3
individual typological angle (ITA)
α_{IT}
quantity used to measure skin colour or melanization level to enable prediction of the MED

NOTE This quantity is derived from the colour coordinates L^* and b^* in the CIELAB colour space (ISO/CIE 2007) by using the formula $\alpha_{\mathrm{IT}} = \arctan\frac{L^* - 50}{b^*}$. The CIELAB coordinates are obtained through spectral reflectance measurements of the skin.

3 Predicting UVR Sensitivity

3.1 Predicting Sensitivity to UVR Using Clinical Parameters – Fitzpatrick Phototypes

In 1975, Fitzpatrick proposed a method of predicting human UVR sensitivity on the basis of a personal history of response to 45 min – 60 min of exposure to midday sun at 20°N to 45°N latitude in early summer (Fitzpatrick 1975; Fitzpatrick 1988; Fitzpatrick and Bolognia 1995). This method utilizes information on both erythema and pigmentation collected in an interview to place individuals in one of the six “phototypes”, as shown in Table 1.

Table 1 – Six phototypes of human skin

Phototype	Skin reactions to UVR exposure	Examples
I	Always burns easily and severely (painful burn); tans little or not at all, and always peels	People most often with fair skin, numerous freckles, red hair, blue eyes; unexposed skin is pinkish white
II	Usually burns easily and severely (painful burn); tans minimally, also peels	People most often with fair skin, some freckles, blond or reddish-brown hair, blue, hazel or brown eyes; unexposed skin is white
III	Burns moderately and tans about average	Normal average Caucasian; few freckles may be present, unexposed skin is white
IV	Burns minimally, tans easily	People with naturally white or light brown unexposed skin, dark brown hair, dark eyes
V	Rarely burns, tans easily and substantially	People with naturally brown skin, dark hair
VI	Never burns and tans profusely	People with naturally dark brown or black skin, dark hair

Persons with the lowest phototypes (and the lowest melanin content in the skin) are the most UVR-sensitive, and those with the highest phototypes (and the highest melanin content) the least UVR-sensitive. This approach gained relatively wide acceptance and usage. It can be combined with instrumental measurements (Gonzalez et al. 2010) (see 3.3 and 4.9).

3.2 An Attempt to Relate Skin Typing to Melanogenesis

The six Fitzpatrick phototypes poorly correlate with measured minimal erythema dose (MED) (Gordon et al. 1998). In an attempt to simplify classification of UVR sensitivity of human skin, a concept of “melano-categories” is introduced in (Fitzpatrick and Bolognia 1995). This makes it possible to replace the six phototypes with three categories. To test the validity of this

Documents
Document Sharing Hub
Copyright International Commission on Illumination
Provided by IHS under license with CIE
No reproduction or networking permitted without license from IHS
Full document details: CIE 207-2014
Licensee=Hong Kong Polytechnic University/9976803100, User=ertert, rtet
Not for Resale, 05/10/2015 03:08:06 MDT