TWENTY-FOURTH ANNUAL CONFERENCE

YUCOMAT 2023

Hunguest Hotel Sun Resort, Herceg Novi, Montenegro
September 4 - 8, 2023

Program
and
Book of Abstracts

Organised by
Materials Research Society of Serbia

Endorsed by
Federation of European Material Societies

CIP – Каталогизација у публикацији
Народна библиотека Србије, Београд

66.017/.018(048)
621.762.5)048)

DRUŠTVO za istraživanje materijala Srbije (Beograd). Godišnja konferencija (24 ; 2023 ; Herceg Novi)
Programme ; and The Book of Abstracts / Twenty-fourth Annual Conference YUCOMAT 2023, Herceg Novi, Montenegro, September 4 - 8, 2023 ; organized by Materials Research Society of Serbia ; [editor Dragan P. Uskoković]. – Belgrade : Materials Research Society of Serbia, 2023 (Herceg Novi : Biro Konto). - XLVII, 183 str. : ilustr. ; 24 cm

Tiraž 220. – Bibliografija uz pojedine apstrakte. - Registar.

ISBN 978-86-919111-8-8

a) Наука о материјалима -- Апстракти b) Технички материјали -- Апстракти
v) Синтеровање -- Апстракти

COBISS.SR-ID 122486537

Title: THE TWENTY-FOURTH ANNUAL CONFERENCE **YUCOMAT 2023**
Program and Book of Abstracts

Publisher: Materials Research Society of Serbia
Knez Mihailova 35/IV, P. O. Box 433, 11000 Belgrade, Serbia
Phone: +381 11 2185-437; http://www.mrs-serbia.org.rs

Editor: Prof. Dr. Dragan P. Uskoković

Conference Secretary: Jasmina R. Jevtić

Technical editor: Dr. Ivana Dinić

Typesetting and prepress: Dr. Aleksandar Dekanski

Covers: Front cover photo: property of MRS Serbia
Back cover photo: J. Erskine-Kelli, Attribution-ShareAlike 2.0 Generic (CC BY-SA 2.0)

ISBN 978-86-919111-8-8

MRSS is member of the
Federation of European Materials Societies

Printed in: **Biro Konto,** Sutorina bb, Igalo – Herceg Novi, Montenegro
Phones: +382-31-670123, 670025, E-mail: bkonto@t-com.me

Circulation: 220 copies. The end of printing: August 2023

P.S.10.

Potential of applying the quadratic failure criteria for short carbon fibre-reinforced PET-G composite material used in additive manufacturing

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Short carbon fibres (SCF) have been introduced in additive manufacturing (AM) of polymer-based parts designed for moderate loadings. Alongside other influential parameters for the strength and stiffness of thus obtained composite materials, scientific papers in AM field emphasize the effect of raster angle (printing direction) applied. Consequently, this study considers the idea of comparing the yield strength values experimentally evaluated for plate specimens additively manufactured from SCF-reinforced PET-G filament applying different raster angles with theoretical tensile strength vs fibre orientation curves already known from Classical Lamination Theory (CLT) for continuous fibre-reinforced composite laminas. Among many failure criteria relevant to ductile isotropic materials, maximum distortional energy criterion (von Mises) is the most widely used. Thus, von Mises criterion is usually used for predicting the onset of yielding in isotropic metals. However, for anisotropic composite materials, such as thin plates made from continuous fibre-reinforced polymers, the use of von Mises failure criterion is not applicable. Therefore, quadratic interaction criteria (*e.g.* Tsai-Hill) are often proposed for such materials. In this study, Tsai-Hill quadratic interaction criterion is implemented in order to predict the onset of yielding (failure) of thin composite plates made from SCF-reinforced PET-G. The off-axis tensile test is used to experimentally evaluate the failure of test samples printed with different raster angles. Linear-elastic material behaviour model was determined by modulus of elasticity and the value of yield strength for each sample set (seven sets were observed, raster angle ranging from 0° to 90° with the increment of 15°). Obtained results suggest that Tsai-Hill quadratic interaction criterion can be considered as a potential candidate for criterion capable to predict the onset of yielding (failure) of thin composite plates additively manufactured from SCF-reinforced PET-G material.