TWENTY-FIFTH JUBILEE ANNUAL CONFERENCE
ON MATERIAL SCIENCE

YUCOMAT 2024

&

THIRTEENTH WORLD ROUND TABLE CONFERENCE
ON SINTERING

XIII WRTCS 2024

Hunguest Hotel Sun Resort, Herceg Novi, Montenegro
September 2 to 6, 2024

APPENDIX

to the

Program

and

Book of Abstracts

Organised by

Materials Research Society of Serbia
&
International Institute for the Science of Sintering

Endorsed by
Federation of European Material Societies

YUCOMAT
Oral Presentations

O.S.II.B.7

Non-destructive testing of composite helmets using ultrasonic thermography

Waldemar Swiderski
Military Institute of Armament Technology, Zielonka, Poland

Personal ballistic covers, i.e. composite helmets (and armor vests), use multi-layer composite materials, which are woven materials (including aramid fibers) connected with plastic as a binder. These types of materials are characterized by the fact that they are light, resistant to corrosion, and can be easily formed, which allows them to be adapted to the surface they are intended to protect. Light ballistic shields are most often several to a dozen or so millimeters thick. Defects that may occur in multi-layer composite materials include defects resulting from the technological process and use. These defects affect the properties of the composites, i.e. their number, dimensions, shape and arrangement. Technological defects are related to the method of producing the cover and arise during an incorrectly conducted technological operation. Defects that may occur in this type of composite materials include: inaccuracies in gluing the composite layers, disbonding, thin gas gaps, most often filled with air, delaminations occurring between the composite layers, occurring during impacts caused by impacts, fragments and shell fire as a result of destructive ballistics tests, material discontinuities, inclusions of foreign materials, flat cracks, etc. The above-mentioned defects may also occur together. Each composite helmet is individual equipment and is used differently by each user. In addition to objective factors affecting its efficiency, such as climatic conditions, its technical condition after many years of operation is also influenced by the user himself. Due to the complicated shape of composite helmets, many non-destructive testing methods are not effective in detecting defects that may occur in them. Among the tests carried out at the Institute using various non-destructive testing methods for helmets, the best results were obtained using ultrasonic thermography. Ultrasonic infrared thermography uses an ultrasonic signal as an excitation source, which leads to thermal excitation of samples and significantly higher temperatures in defective areas compared to adjacent areas without defects. The ultrasonic infrared thermography method has many important advantages over ordinary thermography. The article presents the results of experimental testing.

Presentation time
Friday, September 6, 2024, 11^{00} - 11^{15}
Second YUCOMAT Oral Session, Main Conference Hall

YUCOMAT
Poster Presentations

P.S.I.A.5

Diversifying Properties of Ti_3AlC_2 MAX Phase: Doping with Nb and Mo by Molten Salt-Shielded Synthesis

Filipa M. Oliveira[1], Nima Amousa[2], Amutha Subramani[1], Jan Luxa[1],

Chenrayan Senthil[3], Zdeněk Sofer[1], Jesus Gonzalez-Julian[2]

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This study employs the molten salt-shielded method to dope the Ti_3AlC_2 MAX phase with Nb and Mo, aiming to expand the intrinsic potential of the material. X-ray diffraction confirms the preservation of the hexagonal lattice structure of Ti_3AlC_2, while Raman and X-ray photoelectron spectroscopic analyses reveal the successful incorporation of dopants, with subtle yet significant alterations in the vibrational modes and chemical environment. Scanning electron microscopy with energy-dispersive X-ray spectroscopy characterizations illustrate the characteristic layered morphology and uniform dopant distribution. Density functional theory simulations provide insights into the modified electronic structure, displaying changes in carrier transport mechanisms and potential increases in metallic conductivity, particularly when doping occurs at both the M and A sites. The computational findings are corroborated by the experimental results, suggesting the enhanced material may possess improved properties for electronic applications. This comprehensive approach not only expands the MAX phase family but also tailors their functionality, which could allow the production of hybrid materials with novel functionalities not present in pristine form.

Presentation time
Tuesday, September 3, 2024
First YUCOMAT & WRTSC Poster Session, National Restaurant Jadranka Terrace
Competition for the best Poster Presentation of young researchers
Session: 08^{00} - 09^{45}
YUCOMAT SYMPOSIUM A:
ADVANCED METHODS IN SYNTHESIS AND PROCESSING OF MATERIALS

P.S.III.C.22

Protective coating for current collector materials of direct liquid fuelled molten carbonate fuel cell

Mariia Shved[1], Viktoriya Podhurska[1], Oleksandr Kuprin[2], Jaroslaw Milewski[3]

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Due to the growing problem of global warming, molten carbonate fuel cells (MCFCs) are considered a promising technology for producing clean energy from hydrogen and various fuels such as natural gas, biogas and syngas. MCFCs have a high efficiency of up to 60% and do not produce pollutants, which makes them an attractive alternative to conventional energy generation methods. The MCFCs powered directly by liquid hydrocarbon fuels is an alternative to power generators based on internal combustion engines or gas turbines, desirable for applications away from fixed electricity sources and the fuel grid, as well as for other portable applications.

One of the main challenges is the degradation of MCFC components. The review of the literature shows that one of the main sources of MCFC degradation, which affects the performance and durability of fuel cells, is the corrosion of MCFC parts, mainly current collectors and interconnectors/bipolar plates. Interconnects/bipolar plates provide the supply of the operating gas environment and current transportation in fuel cell stacks. As materials for interconnects, highly alloyed steels, with oxidation resistant and electrically conductive coatings based on spinel or perovskite are traditionally used. One of the methods of protecting and improving the corrosion properties of steels is the application of coatings based on nitrides. The aim of the work is to study the service properties of thin (0.5 mm) stainless steel interconnects with nanostructured coatings of the Cr-N, Cr-Ti-N and Ti-Al-Gd-N systems at 600C in the air.

The coatings were deposited on polished 304L stainless steel specimens using a Cr, Ti-Al, Ti-Al-Gd cathode and the vacuum arc method. Oxidation resistance and electrical conductivity of coatings after long-term (1000 h) holding at 600°C in air were studied. Electrical conductivity of obtained coating was $1.7...3.5 \cdot 10^5$ S/m.

The work was supported by the NATO project SPS G6292 "Direct liquid fuelled Molten Carbonate Fuel Cell for Energy Security (DIFFERENT)".

Presentation time

Thursday, September 5, 2024

Third YUCOMAT Poster Session, National Restaurant Jadranka Terrace

Session: 08^{00} - 09^{45}

YUCOMAT SYMPOSIUM C: NANOSTRUCTURED MATERIALS

WRTCS
Oral Presentations

O.S.II.W.10

Entropy as an Order Parameter in Thermodynamics

Yuri Kornyushin
Maître Jean Brunschvig Research Unit, Chalet Shalva, Randogne, CH-3975

Rudolf Clausius had introduced Entropy as a measure of order/disorder (that is as an Order Parameter) in the early 1850th.
In 1937 Lev Landau had introduced another order parameter also. The order parameter of Landau is different in every specific case. It should be determined for every specific case independently. Entropy is a universal parameter, all the same for every specific case. This is a great advantage.

The author started to use Entropy as an order parameter in the early 1980th.
This technique allowed the author to formulate a general formulation of Thermodynamics of Metastable States [1].
The general theory was reported as a key lecture on the 13th Colloquium on Thermophysical Properties in Boulder, Colorado, USA, and it is available free for everybody on The Net Advance of Physics site of MIT in Metastability topic.

Reference:

1. Kornyushin, Y. Phenomenological Thermodynamics of Metastable States. *J. Non Equilib. Thermodyn.* **2000**, *25*, 15–30.

Presentation time
Wednesday, September 4, 2024, 17^{15}- 17^{30}
Second WRTCS Oral Session, Main Conference Hall