



Trainers Guide

ecoCORK



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MOTIVATION

Material science is continuously being developed, and major industries take advantage of cutting-edge technologies in their applications. As light-weight materials along with superior strength are demanded by the market, composites have come to the fore as the substituent of metal alloys. Although the technical side of industrial applications is compensated by the rise of composites, sustainability and eco-friendly properties of materials, which have important places within the EU policy areas, still require efforts by institutes and companies. At this juncture, composites produced from natural materials such as cork become more of an issue due to their environmentally friendly properties. Leading companies make investments on this issue but there is a lack of human resources in the field, since syllabuses in engineering programs focus on technical sides rather than environmental effects of engineering materials. ECOCORK aims to develop educational tools for gaining environmental awareness in eco-friendly cork composites as well as understanding the importance of cork in sustainability. Within this scope, an educational scheme is concentrated on individuals at college level.

This guide provides an outline for trainers by giving a detailed information about training course in ECOCORK. The first part explains the course details while the second part gives an overview of the modules.

COURSE DESCRIPTION

Introduction

The course program on cork composites in aerospace industry has been developed within the context of an Erasmus+ project, ECOCORK. The aim in this project is gaining environmental awareness in eco-friendly cork composites as well as understanding the importance of cork in sustainability. The target sector is aerospace industry, which is a leading sector for materials science, for the usage of eco-friendly and sustainable natural materials. The course content is prepared by partners from Turkey, Portugal, Spain, Poland and Lithuania.

Short description

In the current educational system, engineering students are led to pure technical courses and thus, students who graduated from engineering faculties feel the lack of social and environmentally conscious. This point is crucial for humanity because competitions in the market lead to a rapidly-growing technology while resulting in irreversible processes harmful to the environment. For this reason, technology developer groups, mainly engineers, should be aware of the side effects of these developments on the environment and humanity. The main reason for the selection of aerospace industry as the implementation sector is that aerospace industry is familiar to cork composites as using them in aircraft, helicopters and space shuttles. As is well known, scientific developments and trends mostly emerge in aerospace industry and then these spread to the other sectors.

Target groups

Main target group is students from the engineering departments of Aeronautical, Aerospace, Mechanical and Materials while research staff and employers from industry is also be benefitted from the outputs.

Objectives

The course objective is to increase the awareness of engineering students about cork composites, which will produce conscious technical staff about sustainability and eco-friendly concepts in aerospace industry.

Methodology

The developed course supports both online and onsite educational systems. An open access book is published as a main reference source for the course content. Various educational materials such as video lectures, reviews, practical assignments and quizzes are derived from this book. All the materials are open to public on an e-learning platform and therefore, it is quite easy-to-access for target groups. Stakeholders and target groups are informed of educational materials by conducting efficient dissemination activities. Visits to stakeholders, participations to seminars, fairs and related organizations as well as presenting outputs in conferences and workshops are carried out by project partners to reach large masses.

Thematic modules

Module-1: Introduction to cork science, cork cultivation, cork harvesting, cork processing

Module-2: Sustainability of cork, carbon footprint of cork, potential products of cork

Module-3: Sectors for cork products, cork properties, future trends for cork

Module-4: Cork-based composites, composite manufacturing methods

Module-5: Aerospace applications of cork demanded properties from the aerospace sector

Key learning outcomes

Upon completion of the training course, the participant will be able to:

- Understand the different stages of cork: cultivation, harvesting and processing
- Understand the sustainability and carbon foot print of cork products
- Understand the cork properties, sectors for cork products and future trends in cork sector
- Understand the manufacturing of cork composites
- Current and potential cork applications in aerospace structures

Assessment methods

Course modules have a self-assessment methodology of quizzes to help participants about consolidating their knowledge and feeling more confident about their skills.

COURSE CONTENT OVERVIEW

There are five modules in this course content. An overview of each module is given in the following pages.

MODULE-1: Introduction to cork science, cork cultivation, cork harvesting, cork processing

Short Description
<p>This module describes the most important steps starting from the specificities of cork forest maintenance and cultivation, followed by all aspects of harvesting the material from the cork tree (techniques, timing) and finally, the many different steps that are necessary to transform the outer bark into a raw material to suitable develop engineering products.</p> <p>In this scope, the contribution of using cork-based raw materials on some of the UN Sustainable Development Goals (safer and inclusive cities, sustainable manufacturing, and others) will be addressed as well.</p> <p>The Module is split into the following subtopics:</p> <ol style="list-style-type: none"> 1. Cork forest - cultivation and maintenance challenges. The different types of cork trees and forests. Planned cultivation to keep the material availability. Threats to cultivation (plagues, climate change, wildfires, etc) 2. Cork extraction techniques and cares. Tools, human qualification, the timing between harvestings, different types and quality of extracted cork. 3. From the bark to raw materials. Mechanical, thermal and microbial treatments. Transformations. Sub-types of raw materials.
Learning Objectives
<p>Upon completion of this module, attendants will be able to:</p> <ul style="list-style-type: none"> ● Understand the different stages of cork: cultivation, harvesting and processing ● Understand how its processing can influence the manufacturing of cork composites for the aerospace sector ● Understand how the processing of cork affects the manufacturing of cork composites
Learning Resources
<ul style="list-style-type: none"> ● Scientific Articles ● Audiovisual material ● Field trips ● Books and Thesis

MODULE-2: Sustainability of cork, carbon footprint of cork, potential products of cork

Short Description
<p>This module describes the importance of cork material in relation to sustainability and the green economy as well as its current and potential uses beyond the well-known cork stopper. We will also establish the relationship between the use of cork and the contribution to the UN Sustainable Development Goals as well as the threats caused by climate change.</p> <p>The Module 2 is divided into the following 3 units:</p> <ol style="list-style-type: none"> 1. Cork and sustainability. <ol style="list-style-type: none"> 1.1. Introduction. 1.2. Cork ecosystem. 1.3. Environmental services. 1.4. Sustainable management. 1.5. Impact of climate change on the cork ecosystem. 2. Carbon footprint of cork products. <ol style="list-style-type: none"> 2.1. Introduction to carbon footprint. 2.2. Carbon fixation of forests. 2.3. Life cycle of cork products. 2.4. Carbon footprint values. 3. Potential uses of cork. <ol style="list-style-type: none"> 3.1. Main properties of cork. 3.2. Construction and design. 3.3. Textile and mobility. 3.4. Pharmacy and cosmetics. 3.5. Others.
Learning Objectives
<p>Upon completion of this module, attendants will be able to:</p> <ul style="list-style-type: none"> ● Understand why cork is considered a sustainable material. ● To know and clarify the concept of carbon footprint and the different steps for its calculation. ● To get an introduction of different uses of cork material and the characteristics that makes it suitable for the aerospace sector.
Learning Resources
<ul style="list-style-type: none"> ● Scientific Articles ● Audiovisual material ● Books and Thesis

MODULE-3: Sectors for cork products, cork properties, future trends for cork

Short Description
<p>The aim of the module is to present in an attractive, visual and technically credible way which and how various properties of cork material influences, creates and drives the sector of cork production. In the module, the participants will enquire knowledge about the characteristic combination of cork's properties which leads to certain applications of cork material. Beginning with characterization of cork material with respect to other materials and underlining its advantages/disadvantages, the participants will possess knowledge about proper application of cork material in accordance with real-world requirements and particularly case studies.</p> <p>The module is split into the following subtopics with described educational activities:</p> <ol style="list-style-type: none"> 1. Cork properties: <ul style="list-style-type: none"> ● Flame resistance and dynamic temperature measurement. ● Experimental testing of cork specimen with High Speed camera, Infrared camera, and Digital Image Correlation measurements 2. Sector of cork products <ul style="list-style-type: none"> ● Computer-aided design (CAD) with 3D scanning and finite element analysis of cork materials subjected to static and dynamic loading - case study. ● Design Thinking focused on cork material and material forming capabilities 3. Future Trends for cork material <ul style="list-style-type: none"> ● Strength, Weakness, Opportunity, and Threat (SWOT) of implementation of cork material with Business Model Canvas for future trends in cork applications
Learning Objectives
<p>Upon completion of this module, participants will be able to:</p> <ul style="list-style-type: none"> ● Assess the capabilities of cork material and justify its applications in various sectors. ● Implement cork material for engineering application focused mostly on aerospace and aeronautical sciences. ● Create a CAD model of a structure where cork is utilized. ● Plan and assess results of mechanical testing experiments for cork materials. ● Present the obtained data in a form of scientific publication ● Use various approaches such as Design Thinking and Business Model Canvas to create more human-oriented cork-based products
Learning Resources
<ul style="list-style-type: none"> ● Scientific open-access publications or publications available via free repositories. ● Conference proceedings. ● Books and Thesis.

MODULE-4: Cork-based composites, composite manufacturing methods

Short Description
<p>This module describes the basics of cork-based composites and the methods of how the composite material is manufactured. We will explain the selection of the most suitable cork material as a filler in the composite material and the structure of a three-layer composite material. As well as the usage of a cork-based composite material in unmanned aerial vehicles.</p> <p>The Module 4 is divided into two main units:</p> <ol style="list-style-type: none"> 1. Cork-based composites. <ol style="list-style-type: none"> 1.1. Three-layer sandwich composites with cork as a core review/types. 1.2. The most important properties and advantages as well as disadvantages of three-layer sandwich composites with cork filling for the aviation industry. 1.3. Areas of usage of three-layer sandwich composites with cork filling in the aviation industry and UAV. 2. Composite manufacturing methods. <ol style="list-style-type: none"> 2.1. Introduction of how composite materials are manufactured. 2.2. Methods of production of three-layer composite elements with cork core: <ol style="list-style-type: none"> 2.2.1. Construction of three-layer sandwich composite material with cork filler using bulk cork granule. 2.2.2. Construction of three-layer sandwich composite material with cork filler using sheets of cork material.
Learning Objectives
<p>Upon completion of this module, attendants will be able to:</p> <ul style="list-style-type: none"> ● Understand how cork-based composites are manufactured. ● Understand what kind of cork material is best suited for composites. ● Understand cork-based composites usage in UAV.
Learning Resources
<ul style="list-style-type: none"> ● UAV Laboratory ● Construction laboratory ● University Airfield Kyviškės ● Scientific articles

MODULE-5: Aerospace applications of cork demanded properties from the aerospace sector

Short Description
<p>This module deals with cork composites in aerospace applications and demanded properties from cork by aerospace sector. Current cork technology in aerospace industry is described in this module. Examples from aerospace applications are given by discussing technical benefits of cork composites. The content of this module is given below.</p> <ol style="list-style-type: none"> 1. Introduction 2. Materials properties of cork composites <ol style="list-style-type: none"> 2.1. Mechanical properties 2.2. Thermal properties 3. Material selection for aerospace applications <ol style="list-style-type: none"> 3.1. Ashby’s method for materials selection 3.2. Decision making methods 3.3. Knowledge based systems 4. Current cork applications in aerospace structures 5. Potential applications of cork composites in aerospace structures
Learning Objectives
<p>Upon completion of this module, attendants will be able to:</p> <ul style="list-style-type: none"> • Understand the technical properties of cork composites. • Understand the current and prospective application areas of cork composites in aerospace structures. • Understand the advantages of cork composites over the other materials in aerospace applications.
Learning Resources
<ul style="list-style-type: none"> • Scientific articles • Audiovisual materials • Research papers • Books and Thesis • Industrial reports