Coordination action for

"Boosting collaboration between research centres and industry to enhance rapid industrial uptake of Innovative Functional Textile Structures and Textile related Materials in a Mondial Market"

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1 TEXTIL Eco-Labels

Consumers are nowadays more sensitive to the protection of the environment. Four out of five would like to buy more environmentally friendly products provided that they are adequately certified by an independent organization. The European Flower represents a reliable guide to easily identify the good environmental performers on the market.

The European flower guaranties:

- A limited use of substances harmful to the environment.
- Reduced water and air pollution
- Textile shrink resistance during washing and drying.
- Colour resistance to perspiration, washing, wet and dry rubbing and light exposure
- It can be awarded to all kinds of textile clothing and accessories, interior textiles and fibres, yarns and fabrics.

(see more details in http://ec.europa.eu/environment/ecolabel/documents/factsheet_textiles.pdf).

The EU Ecolabel is not the only one applied by industries. Below a list of Ecolabels that may be applicable to textiles is given:

(see more details in http://www.ecolabelindex.com/ecolabels/?st=category,textiles)

	http://www.ecolabelindex.com/ecolabel/ABNT		**http://www.bluesign.com/**
	http://www.naaf.no/no/marked_og_produkt/produktguiden/Produktavtaler/		http://www.bmpcotton.com.au/product/
	http://www.ecolabelindex.com/ecolabel/animal-welfare		https://www.carbonfund.org/offset/product-certification

	http://www.bcorporation.net/		http://www.ecolabelindex.com/ecolabel/carbon-neutral-certification
	http://www.bettercotton.org/		http://www.carbon-label.com/
	http://www.bioforum.be/		http://www.certifiedhumane.org/
	http://www.ecolabelindex.com/ecolabel/blue-angel		http://www.wildlifefriendly.org/, http://www.ecolabelindex.com/ecolabel/certified-wildlife-friendly
	http://www.ecolabelindex.com/ecolabel/china-envirolabelling		http://www.greenguard.org/
	http://www.enviro-choice.org.nz/		http://www.ecolabelindex.com/ecolabel/green-shape
	http://www.ecolabelindex.com/ecolabel/envirostars		http://www.ecospecifier.com.au/
	http://www.ecolabelindex.com/ecolabel/compostability-mark-european-bioplastics		http://www.ecolabelindex.com/ecolabel/see-what-you-are-buying-into

	http://www.ecolabelindex.com/ecolabel/fair-for-life		http://www.skal.com/
	http://www.fairtrade.net/		http://mts.sustainableproducts.com/
	http://www.ecolabelindex.com/ecolabel/fairwertung		http://www.ecolabelindex.com/ecolabel/TerraCycle
	http://www.geca.org.au/		http://www.tei.or.th/greenlabel
	http://www.ecolabelindex.com/ecolabel/good-shopping-guide-ethical-company		http://www.ulenvironment.com/
	http://www.greencirclecertified.com/		http://www.windmade.org/
	http://climatop.org		http://www.ecolabelindex.com/ecolabel/eco-leaf-japan
	http://www.ecolabelindex.com/ecolabel/coop-naturaline-switzerland		http://www.ecolabelindex.com/ecolabel/ecologo
	http://www.ecolabelindex.com/ecolabel/cradle-to-cradle-certification		http://www.ecolabelindex.com/ecolabel/ecomark-india
	http://www.ecolabelindex.com/ecolabel/cri-green-label		http://www.ecolabelindex.com/ecolabel/ecomark-japan

	http://www.dsic.org/dsic.htm		http://www.ecolabelindex.com/ecolabel/ecoproof
	http://www.ecolabelindex.com/ecolabel/degree-of-green		http://www.ecolabelindex.com/ecolabel/eco-warranty
	http://www.demeter-usa.org/		http://www.ecolabelindex.com/ecolabel/environmentally-friendly-product-czech-republic
	http://www.ecolabelindex.com/ecolabel/earthsure		http://www.environdec.com/
	http://www.ecocert.com/en/certification		http://www.ecolabelindex.com/ecolabel/etichetta-ambientale
	http://www.ecolabelindex.com/ecolabel/eco-institut		http://ec.europa.eu/environment/ecolabel/index_en.htm
	http://www.ecolabelindex.com/ecolabel/fair-labor-practices-and-community-benefits		http://www.soilassociation.org/
	http://www.global-standard.org/		http://www.texasagriculture.gov/
	http://www.ecolabelindex.com/ecolabel/global-recycle-standard		http://community.timberland.com/Earthkeeping/Green-Index

Bra Miljöval	http://www.snf.se/	Tunisian Ecolabel	http://www.citet.nat.tn/
goodweave	http://www.goodweave.net/	Zque	http://www.ecolabelindex.com/ecolabel/zque
Жива планета	http://www.ecolabel.org.ua/	Recommended by Healthy Child Healthy World	http://healthychild.org/
	http://greenliving.epa.gov.tw/greenlife/green-life/english.aspx	Hong Kong Eco-Label	http://www.ecolabelindex.com/ecolabel/hong-kong-eco-label
Green Tick Sustainable Certified	http://www.greentick.com/	Hong Kong Green Label	http://www.ecolabelindex.com/ecolabel/hong-kong-green-label-hkgls
GUT	http://www.gut-ev.de/	control IMO	http://www.ecolabelindex.com/ecolabel/imo-certified
GreenLabel Singapore	http://www.sec.org.sg/	Korea Eco-Label	http://www.ecolabelindex.com/ecolabel/korean-ecolabel
step Fair Trade Carpets	http://www.ecolabelindex.com/ecolabel/label-step	Considered Design	http://www.ecolabelindex.com/ecolabel/nike-considered-design
MADE-BY	http://www.ecolabelindex.com/ecolabel/made-by		http://www.nordic-ecolabel.org/
made in Green by AITEX	https://www.oeko-tex.com/mig/en/made_in_green/made_in_green_home/home.html	Sustainability Certified NSF Platinum Certified	http://www.nsf.org/business/sustainability/product_carpet.asp?program=Sustainability

	http://www.maxhavelaar.ch/		http://www.ecolabelindex.com/ecolabel/migros-eco
	http://www.ecolabelindex.com/ecolabel/milieukeur-ecolabel-the-netherlands		http://www.textileexchange.org/
	http://www.greenamerica.org/pubs/greenpages/		http://www.oeko-tex.com/
	http://www.ecolabelindex.com/ecolabel/national-programme-of-environmental-assessment-and-ecolabelling-in-the-slovak-republik-npeh		http://www.ecolabelindex.com/ecolabel/oeko-tex-standard-1000
	http://www.ecolabelindex.com/ecolabel/naturland-ev		http://www.ecolabelindex.com/ecolabel/oeko-tex-standard-100
	http://www.naturtextil.com/		http://www.oekocontrol.com/
	http://debio.no/section.cfm?path=4,34		http://www.ecolabelindex.com/ecolabel/sourcemap http://sourcemap.com/
	http://www.tilth.org/		http://www.selosustentax.com.br/selos.php

	http://www.organicfarmers.org.uk/		http://www.ecolabelindex.com/ecolabel/totally-chlorine-free
	http://www.chlorinefreeproducts.org/		http://www.biopreferred.gov/Labeling.aspx
	http://www.scscertified.com/gbc/sustainable_choice.php		

2 Reach

REACH defines the general requirements for generation of information on intrinsic properties of substances. Detailed information can be found via the following link:

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:396:0001:0849:EN:PDF

Testing should be in accordance with Annex VIII, section 8.6 and 8.7 of this REACH document (REGULATION (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006). Annex IX and Annex X may be omitted where justified by information on exposure and implemented risk management measures as specified in Annex XI, Section 3. Annex VIII contains standard information requirements for substances manufactured or imported in quantities of 10 tonnes or more.

2.1 Ecodesign

Ecodesign is an approach to design a product with special consideration for the environmental impacts of the product during its whole lifecycle. In a life cycle assessment the life cycle of a product is usually divided into procurement, manufacture, use and disposal. Ecodesign is a growing responsibility and understanding of our ecological footprint on the planet. Green awareness, over population, industrialization and an increased environmental population has led to the questioning of consumer values. It is imperative to search for new building solutions that are environmentally friendly and lead to a reduction in the consumption of materials and energy. Ecodesign is regulated by the European Ecodesign Directive 2009/125/EC.

Life Cycle Environmental Assessment

As the whole textile product life cycle should be regarded in an integrated perspective, representatives from advance development, design, production, marketing, purchasing and project management should work together on the ecodesign of a further developed or new textile product. In this way, they have the best chance to predict the holistic effects of changes of the product and their environmental impact. Environmental aspects which ought to be analysed for every stage of the life cycle are:

- Consumption of resources (energy, materials, water or land area).
- Emissions to air, water, and the ground (our Earth) as being relevant for the environment and human health.
- Miscellaneous (e.g. health and environmental interrelationship).
- Waste (hazardous waste and other waste defined in environmental legislation) is only an intermediate step and the final emissions to the environment (e.g. methane and leaching from landfills) are inventoried. This also applies to all consumables, materials and parts used in the life cycle phases and all indirect environmental aspects linked to their production.

After making up a list of which phase of the life cycle has which particular environmental aspect, these aspects are evaluated according to their environmental impact on the basis of a number of parameters, such as extend of environmental impact potential for improvement or potential of change.

According to this ranking the recommended changes are carried out and are reviewed after a certain time.

Environmental Effect Analysis

One instrument to identify the factors that are important for the reduction of the environmental impact during all life cycle stages is the Environmental Effect Analysis (EEA).

For an EEA the following information is taken into account:

- Customers' wishes,
- Legal requirements,
- Market requirements (competitors) and
- Data concerning the product and the manufacturing process.

Application in design

Ecodesign concepts currently have a great influence on many aspects of design; the impact of global warming and an increase in CO_2 emissions have led companies to consider a more environmentally conscious approach to their design thinking and process. In building design and construction, designers are taking on the concept of Ecodesign throughout the design process, from the choice of materials to the type of energy that is being consumed and the disposal of waste. With respect to these concepts, online platforms which are only treating Ecodesign products are emerging, with the additional sustainable purpose of eliminating all unnecessary distribution steps between the designer and the final customer.

The use of local raw materials can be considered as **EcoMaterials,** which are less costly and reduce the environmental costs of shipping, fuel consumption and CO_2 emissions generated from transportation. Certified green-textile materials from sustainably managed animals, with accreditations from some Ecolabels can be used. There are several other types of textile materials that can be used in sustainable applications. Recyclable and recycled materials are commonly used in manufacturing of textiles, but it is important to minimize the generation of waste during manufacture or once their life cycle is over. Materials can be given a second life by re-using them in new applications. The re-use of these items means that less energy is consumed in making new products and a new natural aesthetic quality is achieved.

Water Recycling systems such as rainwater tanks that harvest water for multiple purposes and re-using grey water generated during the manufacturing process is a useful way of not wasting drinking water.

There is a huge demand in Western countries to use 'Green' textiles, so there is a lot of effort placed into recycled product design and creating a natural look. But this ideal is not only restricted

to Western countries. It is also important in developing countries, although there the use of recycled and natural products is based on necessity and wanting to get every ounce of use out of a material.

2.2 Ecotoxicological information

Substances:

The name is the same as the one used for the substance in Annex I to Directive 67/548/EEC. However, whenever possible, dangerous substances are designated by their EINECS (European Inventory of Existing Commercial Chemical Substances) or ELINCS (European List of Notified Chemical Substances) names. These are referred to as EC numbers in the mentioned lists. Other entries not listed in EINECS or ELINCS are designated using an internationally recognised chemical name (e.g. ISO, IUPAC). An additional common name is included in some cases.

Index number:

The index number is the identification code given to the substance in Annex I of Directive 67/548/EEC. Substances are listed in the Appendix according to this index number.

Reference Annex I of Directive 67/548/EEC:

http://www.reach-compliance.eu/english/legislation/docs/launchers/launch-annex-1-67-548-EEC.html

Ecotoxicological tests

The short term (eco)toxicity potential of fresh and stabilized textile sludges, as well as the short term (eco)toxicity of leachates obtained from both fresh and stabilized textile sludges, is typically evaluated by a battery of aquatic toxicity tests carried out with bacteria, algae, daphnids, fish, earthworms, and higher plants. The most typical laboratory tests to evaluate aquatic toxicity are the following:

- Short-term toxicity testing on invertebrates (eg. Daphnia sp. Acute Immobilisation Test, following guidelines of the Organisation for Economic Co-operation and Development, OECD 202)
- Growth inhibition study aquatic plants (Algae, Growth Inhibition Test following guidelines, OECD 201)

Activated sludge respiration inhibition testing

The Test Guideline OECD 209 is designed to assess the effects of a substance on micro-organisms from activated sludge of waste-water treatment plants by measuring their respiration rate (carbon and/or ammonium oxidation) as oxygen consumption.

Degradation

Further degradation testing shall be considered if the chemical safety assessment, according to Annex I, indicates further the requirements in relation to the degradation of the substance. The choice of appropiate test(s) will depend on the results of the chemical safety assessment.

Biotic degradation

Further biotic degradation testing shall be proposed if the chemical safety assessment, according to Annex I, indicates the need to investigate further the degradation of the substance and its degradation products. The choice of the appropriate test(s) depends on the results of the chemical safety assessment and may include simulation testing in appropriate media (e.g. water, sediment or soil).

Ready biodegradability

The Guideline OECD 301 F describes the different protocols to screen chemicals for ready biodegradability in aerobic aqueous medium. These tests measure the transformation of a chemical substance into CO_2 and water. The 2 most common test protocols are the following:

- OECD 301 B (Sturm Test) that monitors the evolution of $CO_{2;}$
- OECD 301 F Manometric Respirometry tests that monitor the O_2 consumed.

Mutagenicity

Mutagenicity is an In vitro cytogenicity evaluation that is carried out in mammalian cells or in vitro micronucleus studies and it can be evaluated following the standard OECD 471.

3 Biodegradability Laboratory Tests

A wide variety of biodegradation test methods are used in the industrial, consumer product and military sectors. The selection of the tests is important to avoid customer claims. Tests potentially applicable for functional textiles are following different standards: ASTM (American Society for Testing and Materials), ISO (International Standards Organization), EPA (Environmental Protection Agency).

3.1 ASTM Biodegradation and Composting Test Methods

ASTM D6400 - Standard Specification for Compostable Plastics. ASTM D6400 is a Standard Guide for the complete testing of product compostability.

ASTM D5338 - Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials under Controlled Composting Conditions.

ASTM D5864 - Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or their Components.

ASTM D5929- Standard Test Method for Determining Biodegradability of Materials Exposed to Municipal Solid Waste Composting Conditions by Compost Respirometry.

ASTM D5988- Standard Test Method for Determining Aerobic Biodegradation in Soil of Plastic Materials or Residual Plastic Materials after Composting.

ASTM D6139- Standard Test Method for Determining the Aerobic Aquatic Biodegradation of Lubricants or their Components using the Gledhill Shake Flask.

ASTM E1720- ASTM E172 - Standard Test Method for Determining Ready, Ultimate, Biodegradability of Organic Chemicals in a Sealed Vessel CO_2 Production Test.

3.2 ISO Biodegradation Testing for Ready and Ultimate Biodegradation

ISO 14855- Determination of the ultimate aerobic biodegradability of plastic materials through evolved CO_2 under controlled composting conditions.

ISO 17556- Biodegradation method for determining the ultimate aerobic biodegradability of plastic materials in soil by measuring the oxygen demand in a closed respirometer or the amount of carbon dioxide evolved. Related to OECD, EPA and ASTM D6400 laboratory biodegradation test methods.

ISO 7827- Evaluation in an aqueous medium of the ultimate aerobic biodegradability of organic compounds. Adopted from OECD test methods and harmonized with EPA OPPTS biodegradation laboratory test methods.

ISO 9408- Evaluation of ultimate aerobic biodegradability of organic compounds in aqueous medium by determination of oxygen demand. This allows for determination of both O_2 and CO_2 metrics, and is compatible with ISO 7827, ISO 10707, ISO 10708, and EPA and OECD aerobic biodegradability laboratory test methods.

ISO 9439 - Ultimate aerobic biodegradability of organic compounds in aqueous medium - Carbon dioxide evolution test. The method is adopted from OECD test methods and is harmonized with EPA OPPTS biodegradation laboratory test methods.

ISO 10707- Aqueous medium "ultimate" aerobic biodegradability of organic compounds - Method by analysis of biochemical oxygen demand (closed bottle test). The method is adopted from OECD test methods and is harmonized with EPA OPPTS biodegradation laboratory test methods.

ISO 10708- Ultimate aerobic biodegradability of organic compounds in aqueous medium. Determination of biochemical oxygen demand by poorly soluble organic compounds. Related to ISO 10707 and adopted from OECD test methods for biodegradability. This method is also harmonized to EPA and ASTM biodegradation laboratory testing methods.

ISO 11733- Water quality. Determination of the elimination and biodegradability of organic compounds in an aqueous medium - Activated sludge simulation test.

ISO 14593 - Evaluation of ultimate aerobic biodegradability of organic compounds in aqueous medium - Method by analysis of inorganic carbon in sealed vessels (CO_2 headspace test).

3.3 OECD Biodegradation Test Methods

OECD 301B- Solution Biodegradation by CO_2 Evolution is a 28 days test of a measured volume of inoculated mineral medium containing a known concentration of the test substance. The primary analytical method used in OECD 301B is respirometry based on CO_2 evolution.

OECD 301C-Modified MITI (I) (Ministry of International Trade and Industry, Japan) is a 28 days respirometry test that measures oxygen consumption. It is suitable for poorly soluble materials and can be used with volatile material samples.

OECD 301D - Solution Biodegradation Closed Bottle Test determines biodegradation by dissolved oxygen in a 28 days test. It can be used with poorly soluble materials and is suitable for volatile and absorbing material samples.

OECD 301E- Modified. Solution Biodegradation by Dissolved Organic Carbon. It is a 28 days test that can be used with absorbing material samples.

OECD 301F- Manometric Respirometry by Oxygen Consumption is a 28 days test used for poorly soluble, volatile and adsorbing materials.

The most common methods used for testing biodegradability are the OECD 301 series, being OECD 301 B and OECD 301F the preferred choice for the measurement of biodegradation in aquatic aerobic medium.

3.4 EPA Biodegradation and Compostability Test Methods

For biodegradability testing the EPA and OECD have harmonized the OECD methods as EPA OPPTS (Office of Prevention, Pesticides and Toxic Substances) methods for assessing biodegradability and compostability.

These methods are also either in-part or wholly adopted as ISO methods and/or ASTM biodegradation and composting methods.

4 Antimicrobial Tests (test methods for fungi, bacteria and algae)

Bacteria are causing strong odours and illness; bacterial contamination is the most common type of microbial issue. Control of bacteria is key to good product development.

Fungi have a musty smell that signifies the presence of mold and mildew. It is common in air and soil and can be seen on water damaged walls, concrete and coatings.

Algae are seen in water environments exposed to sunshine. Algae grow on nearly all materials: tarps, coverings, siding, roofing and walls. The control of algae is often difficult.

4.1 Antimicrobial Product and Application Development

Microbial Resistant Product and Application Development

Antimicrobial or microbial resistant products utilize additives (silica nanospheres, nano silver, N-halamine-based, silver substituted zeolites,…) or coatings (e.g. ægis®) that prevent the growth of organisms on the treated product. Formulated products can be divided into two categories each requiring different development and formulation strategies:

4.1.1 Antimicrobial Product Development

There are numerous types and classes of materials used with antimicrobial additives. Each material has a set of additives that will be best compatible with both the material and the manufacturing requirements.

Examples of plastics and composites that can be doped with antimicrobial additives are: Nylon, Kevlar, polyamide, polyethylene, polycarbonate, polypropylene, polyester, ABS (Acrylonitrile butadiene styrene), PVC (Poly(vinyl chloride), polystyrene, cotton, cellulose, rayon, wood pulp, binder, etc.

4.1.2 Microbial Application Development

Steps in New Antimicrobial Application Development.

The first step in development of an antimicrobial product is to determine the microbial performance requirements of the product and the stringency of its use in the environment.

Plastics, paper, coatings, metals, wood and textiles can require different considerations in the development cycle depending on the antimicrobial additive and the requirements of the finished product.

Generally there are three criteria to be considered for a given application:

1. Which antimicrobial additive fits the application requirement?
2. How much additive will be necessary for the desired end use performance?
3. When and how does the additive need to be applied to perform the desired action?

Material properties and manufacturing processes will dictate the types of additives that can be used. Textiles may be treated with antimicrobial agents for a range of reasons depending on the market sector and application area. Antimicrobials are typically applied to give textiles improved resilience against microorganisms (e.g. preventing destruction of polymers, discoloration) and increased durability of the textile leading to a longer lifetime of use. Antimicrobials can also be used to protect textiles against colonization of odor-forming bacteria. They may also be applied to textiles to play a role in addressing hygiene in clinical and sensitive environments, by minimizing the chances for microbial colonization of textiles and the potential for transfer from fabric surfaces. There are many strategies for addressing the care and cleanliness of textiles, including regular laundering and treatment with laundry chemicals. Antimicrobial treatments do not seek to wholly replace laundering and other cleaning methods. However, antimicrobial treatments can provide consumers with an option to consciously reduce the frequency and/or intensity of laundering, which can give potential for significant savings in water use, energy consumption and reduced need for chemical consumables in textile care. Considering that the majority of resources used in the life of a textile occurs in the use and care phase, this can be a significant environmental benefit. For consumers looking for ways to reduce their environmental footprint in daily life, textiles that require less intensity of care can provide a way to contribute to this goal.

Triclosan, silane quaternary ammonium compounds, zinc pyrithione and silver-based compounds are the main antimicrobials used in textiles. The synthetic organic compounds dominate the antimicrobials market on a weight basis. On the technical side, the application rates of the antimicrobials used to functionalize a textile product are an important parameter with treatments requiring lower dosage rates offering clear benefits in terms of less active substance required to achieve the functionality.

In Table 1 the type of antimicrobial used in textile applications is shown.

Textile application	Ag	TCS	Si-QAC	ZnPT	Other organics [a)]
Apparel (sports, workwear, undergarments etc.)	++	++	++	+	−
Medical	++	+	++	+	−
Bedding	++	+	++	−	++
Mattresses & mattress covers	−	(+)	+	++	++
Outdoor (tents, tarps)	(+)	(+)	(+)	()	(++)

++ Effective technology and in common commercial use; + Some technical limitations however is in commercial use; ( ) Major limitations but found in commercial use; − Limited applicability and unknown commercial use. [a)]n-octyl-isothiazolinone (OIT), benz-isothiazolinone (BIT), 10,10′-oxybisphenoxarsine (OBPA);

Table 1-Type of antimicrobial used in textile applications [1]

[1] Lena Windler, Murray Height, Bernd Nowack; Comparative evaluation of antimicrobials for textile applications Review Article Environment International, Volume 53, March 2013, Pages 62-73;

4.2 ASTM Microbial Test Methods

Microbial test methods exist for bacteria, fungi, algae, and biodegradation for industrial and consumer products. Common ASTM antimicrobial and biodegradation testing projects include test methods **G21, D3273, D5590, D6400, D6868**, used for plastic, coatings, paper, paint, textiles, lubricants and personal care products.

ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi. The ASTM G21 test is for testing antifungal and fungicide treated products.

ASTM D3273 - Standard Test Method for Resistance to Mold on the Surface of Interior Coatings in an Environmental Chamber. The ASTM D3273 is for testing antifungal and fungicide treated products, and unlike the G21, the D3273 has a durability component as part of the method.

ASTM D5590 - Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay. The ASTM D5590 is for testing antifungal and fungicide treated products in a plate assay.

ASTM D6400 - Standard Specification for Compostable Plastics. ASTM D6400 is a multi-component environmental biodegradation test that evaluates both inherent and ultimate biodegradability using laboratory methods that assess composting of the tested materials relative to control samples. Additional components of the ASTM D6400 test protocols include: elemental analysis and plant seed germination (phytotoxicity).

ASTM D6868 - Standard Specification for Biodegradable Plastics used as Coatings on Paper and other Compostable Substrates.

ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.

ASTM C739 - Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation. Determination of antifungal properties.

ASTM D2020 - Standard Test Methods for Mildew (Fungus) Resistance of Paper and Paperboard.

ASTM E2275 – 14 Standard Practice for Evaluating Water-Miscible Metalworking Fluid Bioresistance and Antimicrobial Pesticide Performance. This practice provides laboratory procedures for rating the relative bioresistance of metalworking fluid formulations, for determining the need for microbicide addition prior to or during fluid use in metalworking systems and for evaluating microbicide performance.

ASTM D4300 - Standard Test Methods for Ability of Adhesive Films to Support or Resist the Growth of Fungi.

ASTM D4783 - Standard Test Methods for Resistance of Adhesive Preparations in Container to Attack by Bacteria, Yeast, and Fungi.

ASTM D5660 - Assessing the Microbial Detoxification of Chemically Contaminated Water and Soil using a Toxicity Test with a Luminescent Marine Bacteria.

ASTM E1259 - Standard Practice for Evaluation of Antimicrobials in Liquid Fuels Boiling below 390°C. ASTM E1259 is one of few methods for determining the preservation of fuel and biofuel products.

ASTM E1428 - Standard Test Method for Evaluating the Performance of Antimicrobials in or on Polymeric Solids against Staining by Streptoverticillium reticulum (A Pink Stain Organism).

ASTM E2149 - Determining the Antimicrobial Activity of Immobilized Antimicrobial Agents under Dynamic Contact Conditions. The ASTM E2149 is used in testing textiles that have been treated with antibacterials or biocides. Quat-Silane antimicrobials are commonly tested using this method.

ASTM E2180 - Standard Test Method for Determining the Activity of Incorporated Antimicrobial Agent(s) in Polymeric or Hydrophobic Materials.

ASTM E2275 - Standard Practice for Evaluating Water-Miscible Metalworking Fluid Bioresistance and Antimicrobial Pesticide Performance. ASTM E2275 is commonly used in testing metal working fluid MWF preservation against bacteria and fungi, including Mycobacteria (is a genus of Actinobacteria, that includes pathogens known to cause serious diseases in mammals).

ASTM E2315 - Standard Guide for Assessment of Antimicrobial Activity using a Time-Kill Procedure. The ASTM E2315 is typically used to test disinfectants against bacteria and yeast fungi.

ASTM G29 - Standard Practice for Determining Algal Resistance of Plastic Films. The ASTM G29 algae test method is for testing algae and algaecide formulations or treated products.

4.3 AATCC Textile and Microbial Test Methods

AATCC: American Association of Textile Chemists and Colorists. AATCC provides test method development, quality control materials, and professional networking for thousands of members in 60 countries throughout the world.

Antimicrobial laboratory testing for textiles is similar to many applications, in that the manufacturing process uses either coatings or processes that incorporate the antimicrobial onto or into the fibre of the finished fabric.

A critical aspect, unique to antimicrobial textiles, is the application process and the fit of the antimicrobial used. Different laboratory tests are more or less appropriate depending on the antimicrobial and how it is applied to the finished textile.

Common test methods for microbial testing of textile materials for bacteria, fungi and algae resistance include: AATCC TM 100, AATCC TM 147, and AATCC 30 for antimicrobial and microbiological testing of textiles.

Below are a few of the more common AATCC microbiological laboratory test methods used for testing antimicrobial performances :

AATCC 30 - This antimicrobial test is a quantitative method to determine the susceptibility of textile materials to mildew and rot and to evaluate the efficacy of fungicides on textile materials. The AATCC TM 30 is a four part test comprising AATCC 30 part 1 to 4. Each AATCC 30 subpart is treated as a separate antifungal test.

AATCC 61 - Colour fastness to Laundering: Accelerated. An accelerated aging test used partly to determine the antimicrobials efficacy over time. Generally used in 5 wash and 25 wash equivalents.

AATCC 100 - This antimicrobial test is a quantitative method in which assessment of antibacterial finishes on textile materials (fabric finishes, etc.) is determined by the degree of antibacterial activity intended in the use of such materials. The AATCC 100 or TM 100 is an antibacterial textile test method used to assess textiles treated with antimicrobial products as a part of the finished textile coating.

AATCC 147 - This test method is a qualitative antimicrobial test used to detect bacteriostatic activity on textile materials. It is useful for obtaining a rough estimate of activity by the size of the zone of inhibition and the narrowing of the streaks caused by the presence of the antimicrobial agent permitting an estimate of the residual antimicrobial activity after multiple washings.

The AATCC TM 147 is for testing antibacterial, bactericidal, bacteriostatic activity and provides a qualitative zone of inhibition type of result around the treated article.

AATCC 174 - The AATCC 174 test method is designed to determine the antimicrobial activity of new carpet materials and consists of three procedures: one related to qualitative antibacterial properties, the second relative to quantitative antibacterial properties and the third corresponds to quantitative antifungal properties of carpet fibres and materials.

AATCC 194 - Assessment of the Anti-House Dust Mite Properties of Textiles under Long Term Test Conditions.

There are also several related ISO standards used in the testing of textile resistance to bacterial and fungal growth. Which microbial test method is appropriate is determined by considering the use environment, antimicrobial type and application method.

4.4 ISO European Microbial Test Methods

Bacteria, fungi and algae testing of industrial and consumer products for business, government and society is done using methods developed by the International Organization for Standardization (ISO). Common tests include:

Concrete. Adapted method ISO 22196 for determination of antibacterial resistance of concrete to Thiobacillus sp.

ISO 22196 - Measurement of antibacterial activity on plastic surfaces. Based on the JIS Z 2801 method.

ISO 846 (1978, reviewed 2012) - Plastics: evaluation of the action of microorganisms. This International Standard specifies methods for determining the deterioration of plastics due to the action of fungi and bacteria and soil microorganisms. The aim is not to determine the biodegradability of plastics. The type and extent of deterioration may be determined by visual examination, and/or changes in mass and/or changes in other physical properties.

DIN EN ISO 20645 (2005) - Textile fabrics - Determination of antibacterial activity - Agar diffusion plate test.

DIN EN ISO 20743 (2007) - Textiles - Determination of the antibacterial activity of antibacterial finished products.

4.5 MIL STD and JSS Military Standards Test Laboratory

The USA Military Standard (U.S. DOD MIL STD) and Indian Military JSS (Joint Service Specifications) testing is used for all material and product types, including textiles, plastics, resins, coated metals,

webbing, foam, and polymers. Common test methods include: US 810g 508 and JSS 55555 "Penta-Five" standards.

MIL-STD 810E Section 508.4. Military Standard Environmental Test Methods and Engineering Guidelines 810E 508.4 - Fungus. Used for testing materials with a cycling 24 hours at certain temperature profile. This test runs a minimum of 28 days but is recommended for 84 days.

MIL STD 810G Section 508.6. Military Standard Environmental Test Methods and Engineering Guidelines MIL-STD-810G section 508.6 - Fungus. The purpose of this fungus test is to assess the extent to which material will support fungal growth and how any fungal growth may affect the performance or use of the material.

4.6 Japanese Industrial Standards (JIS) Test Laboratory

Common tests for bacteria and fungi testing of textiles and durable industrial and consumer products using Japanese Industrial Standard (JIS) methods developed by the Japanese Standards Association (JSA) include: JIS 1902 and JIS Z 2801.

JIS L 1902 - Laboratory Testing for Antibacterial Activity and Efficacy on Textile Products. Method JIS 1902 can be used for both antibacterial and antifungal testing against various bacteria and fungi on textiles. It is a quantitative determination of bacterial growth on textiles in a low nutrient environment.

JIS Z 2801 - Antimicrobial Surface Test for Antimicrobial Activity and Efficacy on Polymeric Surfaces. The JIS Z 2801 is used for durable products typically contaminated with bacteria. It is a common test used for silver treated products such as medical devices but is not an EPA or FDA registered or approved test method.

4.7 Other Ecodesign initiatives

Further there are some ecodesign initiatives in the textile industry which have permitted the development of new ecodesigned products. For example, the CIM-ECO programme in the East of France (http://eureka.lorraine.eu/jahia/Jahia/en/pid/2612?breve=18749).