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CAMOUFLAGE TEXTILE

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ABSTRACT

The article presents new textile structures (woven and knitted fabrics) featuring camouflage properties in visible (VIS) and near infra-red (IR) radiation bands. The textiles were designed and made for masking individuals and their personal equipment. Their design, diversified by applied yarns, weaves and way of distribution of metalised yarns on the surface of fabrics is discussed. Levels of the resulting physical, mechanical and functional parameters of woven and knitted fabrics are presented, both raw and after finishing treatment. [1]

INTRODUCTION

The word 'camouflage has its origin in the French word camoufler which means 'to disguise. When the word entered the English dictionary initially, it had a limited meaning, implying concealment or disguise of military objects in order to prevent detection by the enemy. [2] The purpose of camouflage is preventing the detection and identification of objects, in the broad sense of the word, by misinforming, pretence and hiding. The development of modern detection means which work in a wide range of electromagnetic radiation stimulates the development of camouflage agents, including paint, screens, Marquette's and camouflage cover.[1]

Camouflage helps an organism blend in with its surroundings. Camouflage can be colors or patterns or both. Camouflage textiles not only help protect armed forces from visual and IR detection but also-with regards to their heat and sweat management capabilities-ensure that the soldiers can perform to the best of their abilities even in extreme climatic conditions.

The basic requirement of camouflage textiles are:

Physical lightweight and durability
Non glaring/shining
High tear and tensile strength
Comfort wear and antistatic,
Shade stability and high light, wash and perspiration fastness
Windproof, water repellent or even water proof and breathable
Flame retardant
Antimicrobial, insect, mosquito repellent [3]

TYPES OF CAMOUFLAGE

-Natural and artificial camouflage, UV camouflage, Camouflages for visible region, NIR camouflage, Thermal IR camouflage, Anti radar camouflage, Camouflages for multiple spectra [5]

In the modern world there are now many different types of camouflage ranging from Brushstroke (pattern appears to have been painted with a paint brush) type patterns to DPM (Disruptive Pattern Material) and the more up to date MTP (Multi-Terrain Pattern) newly issued to the British Army. Given the amount of different patterns over the years and various styles adopted by different countries it can be easy to become confused between them The different types of camouflage fall into 13 main headings:

Brushstroke – British WW2 pattern derivatives

Chocolate Chip –US six-color desert and its derivatives
Digital patterns (CADPAT, MARPAT etc.)
DPM (British) – Disruptive Pattern Material
Duck hunter – US M1942 spot pattern derivatives
Flecktarn – the German flecktarnmuster and its derivatives
Leaf – US M1948 ERDL derivatives
Lizard – French or Portuguese pattern derivatives
Puzzle – "jigsaw puzzle" patterns (Belgium, Yugoslavia etc.)
Rain – used by many Warsaw Pact Countries
Splinter – German WW2 Wehrmacht, Bulgaria, Sweden etc.
Tiger stripe – Vietnam War era pattern
Woodland – US M1981 derivatives[6]

NATURAL CAMOUFLAGE

Colours and patternsdisplayed in natural camouflage are called cryptic colours and patterns.[7]
Mimetic camouflage
Disruptive camouflage

Mimetic camouflage :-

Mimicry Some animals and plants look like other things they mimic them. Mimicry is another type of **deceptive coloration**. It can protect the mimic from predators or hide the mimic from prey.If mimicry was a play, there would be three characters.

The **Model** - The species or object that is copied.

Mimic - looks and act like another species or object.

Dupe- the tricked predator or prey. The poisonous coral. Snake and the harmless king snake look a lot alike. Predators will avoid the king snake because they think it is poisonous. This type of mimicry is called Batesian mimicry. [8]

Buntfarbenaufdruck ('multicoloured colour print'), which was originally developed for the Reichswehr ('Territorial Defence'), employsgeometric shapes that are clearly derived from dazzle camouflage and, like dazzle camouflage, were intended to confuse the focal visualsystem. Instead of bright colours, however, Buntfarbenaufdruck uses wood brown and medium green polygons on a light Feldgrau.[9]

Crypsis by **disruptive camouflage** counter shading, which defeats a predator's ability to identify prey by shape. In **countershading,** the upper parts of an animal are dark and its lower parts are light. This reverses the normal distribution of luminance on objects, which are usually lit from above. **boundary disruption**, Each zebra's stripes blend with the stripes of the other zebras around it. This kind of camouflage is called boundary disruption, and it confuses predators, which tend to see only a large, striped mass instead of many individual animals.

ARTIFICIAL CAMOUFLAGE

Digital Camouflage

Digital camouflage is a type of camouflage pattern combining micro- and macro patterns, often though not necessarily with a pixellated look created with computer assistance. The function is to provide military camouflage over a range of distances. The "digital" refers to the coordinates of the pattern, which are digitally defined. The term is also used of computer generated patterns like the non-pixellated Multicam and the Italian fractal Vegetato pattern. According to the patent for MARPAT, pixellation does not in itself contribute to the camouflaging effect. The pixellated style, however, simplifies design and eases printing on fabric, compared to traditional patterns. While digital patterns are becoming widespread, critics maintain that the pixellated look is a question of fashion rather than function .The basis of digital camouflage are three basic principles:

Bi- or multi scale patterns - add high spatial frequency texture components that add concealment at closer ranges

Dithering - the production of intermediate colours where two fields of colour meet

Edge effect – to modify visual processing of edges [10]

Thermal Camouflage

A thermal camouflage tarpaulin (heavy waterproof cloth for covering) for hiding heat sources against detection in a thermal image, comprising a base textile composed of a loop-formingly knitted or woven glass fabric is provided on the side which is remote from the heat source with a compound whose reflectance values are in the region of a visual camouflage and/or in the infrared region. Said base textile is provided on that side which faces the heat source with a free-standing polyester film to which has been applied a vapor-deposited coating which reflects thermal radiation [11]

MATERIAL USED FOR CAMUFLAG TEXTILE

In manufacturing of the camouflage materials that secure protective features in visible and NIR spectral ranges these coloration technologies are dominant:

− use of special selected dyes and pigments
− incorporating strongly IR absorbing pigments into printing paste
− incorporating strongly IR absorbing pigments into the polymer at a fiber forming process
− use of special and minimizing IR reflectance coatings (layers)

It is relatively easy to print a wide range of textile fibre types in the correct visual shades with the colour fast dyes. However it is more difficult to achieve NIR cover on the same fabric. Artificial fibres such as polyamide, polyester, aramids and their blends with natural fibres cause these particular problems. The camouflage should stay efficient during all the wearing time, so the colour fastness to various influences and treatments becomes an extremely important parameter, ensuring the concealment of the target both in the visual and NIR radiation spectral ranges. The aim of this study was to analyze the drawbacks of the military clothing currently worn by Lithuanian army, to identify special requirements posed for today‘s military camouflage and to investigate the wearing influence to the efficiency of the concealment properties in visual and near IR spectral range of newly developed woodland camouflage woven fabrics, intended for Lithuanian army outdoor uniforms.

In short, **stealth** comprises various means employed in offence to avoid detection by the other party. One typical example where stealth plays a very important role is the fighter aircraft. The aircraft in the air is seen conspicuously against a uniform background if it is not made stealthy. Similarly, a ship on a uniform background of sea and/or sky can be easily detected unless made stealthy. Ofcourse, on land, there is a lot of heterogeneity for a military object such as a tank. Tanks of the future may also have to be made stealthy. Stealth technology or low observable technology deals with the design of weapon platforms from the beginning stage itself to include low observable features as a major design goal, rather than as a retrofit capability. The various signatures that are to be considered in a stealth warship are:

Radar, Infrared, Acoustic, Magnetic, Electric, Hydrodynamic wake, Extra low frequency, Miscellaneous such as contaminants, bioluminescence etc.[2]

VISUAL CAMOUFLAGE

DMSRDE has been working on the development of camouflage paints and synthetic nets. The laboratory has developed paints and pre-garnished light weight synthetic camouflage nets for visible and NIR regions, conforming to colour schemes/patterns suitable for green belt areas, desert terrains and coastal areas. It has also developed polystyrene emulsions, polystyyene solvents and silicate based camouflage paints for effectively camouflaging runways and taxi tracks.[12]

BASIC PRINCIPLES OF CAMOUFLAGE IN THE VISIBLE REGION
Hiding,
Blending,
Deception, and
Miscellaneous techniques.

Hiding
In hiding, the objects are physically hidden by the use of natural materials such as vegetation natural and cut and artificial materials such as nets, screens etc.

Screens
A variety of screens, such as horizontal, vertical and overhead types, are used for concealing stationary military objects. These screens act as physical barriers between the target and the sensor. Besides, there are smoke screens which provide temporary concealment in situations such as movement of troops.

BLENDING

In camouflaging by blending, the object is made to blend with the background. The object becomes an integral part of the background and is hence rendered invisible, and thereby unrecognizable. Camouflaging by blending involves optical principles which produce illusory effects. Principles which nature has applied to camouflage various animals

COLOUR MATCHING

The first requirement for an object to blend with its general background is that the colour of the object should be the same as that of the background.

DISRUPTIVE COLOURATION

Obliterative shading is not possible for all directions of incident light. As such, colour matching and simultaneous countershading is not possible under all conditions. One of the most important principles of camouflage is that produced by dazzle. It is an American term which came into popular use during war in connection with camouflage painting of military objects. When an object is painted with irregular patches of colours of varying contrast and tones, the attention of the observer is diverted away from the actual shape of the object but drawn towards the dazzling patches. The patterns which attract attention do not bear any relationship with the shape of the object with which the observer is familiar [2]

INFRARED CAMOUFLAGE

The term infrared camouflage denotes any device or equipment or technique employed to counter detection by an infrared system. Advances in infrared sensor technology have put great stress on infrared camouflage and demanded counter-measures.[2]

PROPERTIES OF INFRARED RADIATION

Propagation Characteristics Infrared radiation travels with the speed of light, like any other type of electromagnetic radiation, and, in its transit from the source undergoes reflection, scattering, absorption, transmission, diffraction and polarization. In most of the cases, the intervening medium between the source and the detector is the atmosphere. As the radiation passes through the atmosphere, it gets attenuated by its interaction with the various constituents of the atmosphere. This process is known as extinction. Visual vulnerability The detection prbbability, aided or unaided, is dependent on shape, size, hue, colour contrast, mobility:

i) High - locations near the forward edge of battlefield area (FEBA); here visual surveillance is maximum; movement is also frequent.

ii) Medium - direct ground observation stand-off aerial sensors;

iii) Low - subject to only long range airborne reccee; blending with background is high. Infrared detection vulnerability Very-short wave infrared (VSWIR) - detection is by imaging systems :[2]
DMSRDE has developed paints in various shades, e.g. olive green, deep brunswick green, light green biege, and dark brown, having suitable NIR reflectance, values. [12]
NIR region, reflectance profile of target should be matched with reflectance profile of natural materials.
Important natural materials are sand, soil, and leaves.
Reflectance properties of these objects must be matched by camouflage materials.[13]

MICROWAVE CAMOUFLAGE

DMSRDE has obtained encouraging results in the development of light weight microwave absorbers using Retinyl Schiff base salts. These were synthesized in the laboratory and characterized by IR spectroscopy and elemental analysis. Absorber samples of finite thickness were prepared and tested for radar absorption at X-band frequencies.

MULTISPECTRAL.CAMOUFLAGE MATERIALS

DMSRDE and DW have been carrying out R&D on development of multi-spectral camouflage materials. DW has synthesized a large number of materials such as conducting polymers, liquid crystals, liquid foam and materials for anti-reflective coatings. DMSRDE has initiated a programme for developing a multi-spectral camouflage system which should be able to cater for visible, NIR, thermal IR and centimeter and millimeter wave radar regions. [12]

MILITARY TEXTILES:

Through nanotechnology, new personnel camouflage systems can be developed that can change pattern and colors as environment changes. "Chameleonic" camouflage allows the soldier to become a mirror of his surroundings. Other nanotechnological developments include the use of fibers which can stimulate muscles and thereby give soldiers greater strength for lifting or jumping.[14]

Military Camouflage Military camouflage is the use of camouflage by a military force to protect personnel and equipment from visual observation by enemy forces. In practice, this means applying colour and materials to military equipment of all kinds, including vehicles, ships, aircraft, gun positions and battledress, either to conceal it from visual observation (crypsis), or to make it appear as something else (mimicry).

Sensor Systems in Military Applications Active. Active sensors emit energy that reflects from targets and is recaptured by the emitting or other nearby unit, indicating the presence of a target. Active sensors are searchlights and radars. Passive. Passive sensors emit no energy. This type of sensor collects energy, which may indicate the presence of a target. Examples of passive sensors are the human eye, night vision devices, and photographs. Threats in Military Applications Image Intensifiers Low-Light Television (LLTV).Aerial Reconnaissance, Remote Sensing, and Imagery Near Infrared (NIR) Sensors IR Sensors UV Sensors Radar. Camouflage Systems The aim is to make sure that the surface of the soldiers and not form a contrasting shape against the background. The principles involved in camouflage materials are shape, shine, shadow, silhouette, surface, spacing and movement. The hues used in the camouflage are green, olive, khaki, brown and black

PRINCIPLES

COMPROMISE

No single camouflage pattern is effective in all terrains .The effectiveness of a pattern depends on contrast as well as colour tones. Strong contrasts which disrupt outlines are better suited for environments such as forests where the play of light and shade is prominent While civilian hunting clothing may have almost photo-realistic depictions of tree bark or leaves (indeed, some such patterns are based on photographs),military camouflage is designed to work in a range of environments. With the cost of uniforms in particular being substantial, most armies operating globally have two separate full uniforms, one for woodland/jungle and one for desert

MOVEMENT

While patterns can provide more effective crypsis than solid colour when the camouflaged object is stationary, any pattern, particularly one with high contrast, stands out when the object is moving. Jungle camouflage uniforms were issued during the Second World War, but both the British and American forces found that a simple green uniform provided better camouflage when soldiers were moving. After the war, most nations returned to a unicoloured uniform for their troops. Some nations, notably Austria and Israel continue to use solid colour combat uniforms today. Similarly, while larger military aircraft traditionally had a disruptive pattern with a darker top over a lighter lower surface (a form of counter shading), modern fast fighter aircraft often wear gray overall.

DIGITAL CAMOUFLAGE

Digital camouflage provides a disruptive effect through the use of pixellated patterns at a range of scales, meaning that the camouflage helps to defeat observation at a range of distances.

NON-VISUAL

Stealth technology by class corvettestealth With the birth of radar and sonar and other means of detecting military hardware not depending on the human eye, came means of camouflaging against them. Collectively these are known as **stealth technology.** Aircraft and ships can be shaped to reflect radar impulses away from the sender, and covered with radar-absorbing materials, to reduce their radar signature

APPLICATION

UNIFORMS

The role of uniform is not only to hide each soldier, but also to identify friend from foe. Armies facing service in different theatres may need several different camouflage uniforms. Separate issues of temperate/jungle and desert camouflage uniforms are common. Patterns can to some extent be adapted to different terrains by adding means of fastening pieces of vegetation to the uniform. Helmets often have netting covers; some jackets have small loops for the same purpose.Being able to find appropriate camouflage vegetation or in other ways modify the issued battle uniform to suit the local terrain is an important skill for infantry soldiers.

LAND VEHICLES

The purpose of vehicle and equipment camouflage differs from personal camouflage in that the primary threat is aerial reconnaissance.

SHIPS, AIRCRAFT

Aircraft camouflage faces the challenge that an aircraft's background varies widely, according to whether the observer is above or below the aircraft, and with the background, e.g. farmland or desert. Aircraft camouflage schemes have often consisted of a light colour underneath and darker colours above.

IN FASHION AND ART

Fashion and the "Dazzle Ball" The scheme of decoration for the great fancy dress ball given by the Chelsea Arts Club at the Albert Hall, the other day, was based on the principles of 'Dazzle', the method of 'camouflage' used during the war in the painting of ships ... The total effect was brilliant and fantastic.

CAMOUFLAGE IN ART

War protesters and fashionist as Through nanotechnology, new personnel camouflage systems can be developed that can change pattern and colors as environment changes. “Chameleonic” camouflage allows the soldier to become a mirror of his surroundings Non-military use of camouflage includes making cell telephone towers less obtrusive and helping hunters to approach wary game animals. Patterns derived from military camouflage are frequently used in fashion clothing, exploiting their strong designs and sometimes their symbolism. and works of literature.[1][3]

CONCEALMENT

Concealment is a widely adopted method of camouflage. In nature, there are a variety of backgrounds characterised by homogeneity and heterogeneity in colour, and structural simplicity and complexity. The predominant colours of various backgrounds are green and brown, besides sea blue and grey. Animals are concealed in their respective backgrounds are:

Colour matching
Countershading
Disruptive colouration and
Shadow suppression

RADAR

The word radar is an acronym for Radio Detection and Ranging. Broadly, it deals with the process of detection of radio objects and finding their distances (ranging). The basic principle behind the operation is the fact that electromagnetic waves get reflected whenever there is a change in the properties of the medium. The properties involved are the conductivity, the permittivity and the permeability. Radar sends a burst of electromagnetic energy and
records the reflected signal (the echo) from the targe

Radar Absorbimg Materials (Ms)

Absorption of various radar absorbing materials. Salient aspects of the RAMS have been discussed by reduction of RCS by shaping of the composite part responsible for contributing towards radar echo is possible, in case the change of shape does not adversely affect the performance of the intended role of the component or the system as a whole. Also, once the design is completed and the system is in the final form, reshaping of any composite part may not be possible. In all these situations reduction of RCS can be done by the application of radar absorbing materials (RAMS). **Jaumann absorber** and **Graded dielectric absorber** These are multilayer absorbers which extend the bandwidth and **Dallenbach** absorbers. In the **Jaumann absorber**, the impedance tapers off from layer to layer starting from the front sheet to a low value for the ground plane. The electrical properties are controlled by varying the amount of fillers in each layer in order to achieve the required amount of absorption characteristics. **Radar absorbing properties** can be imparted to the target through mechanical design of the composite structure. These are known as Radar Absorbing Structures (RAS).

RADAR ABSORBING STRUCTURES (RAS)

So far, we have discussed materials which are required to be applied to the surface of the target in order to impart radar absorbing properties to it. That is, we make the assumption that the structural material of which the target is made has no radar absorbing properties. Current Research on Radar Absorbing Materials It has been reported that conducting polymers have high potential as radar absorbing materials. Retynl Schiff base salt is a recently developed RAM coating. [2]

CAMOUFLAGE/RADAR SHILDING

-Camouflage material incorporates means for specifying and providing predetermined degree of reflection of incident radar waves which is optimum for particular use environments. The overall pattern is the resultant of control of reflection of longer radar wavelengths by a layer of electrically conductive fibrils of controlled density and reflection of shorter radar wavelengths by thin mosaic layer of metal.

-Metafil Mat is the ultimate material to provide effective shielding from electromagnetic interference. Our Metafil Mat is used in radar blocking equipment for the military and in shielding for satellite antennae.

-Metafil consists of aluminum coated glass fibers thermally bonded into a nonwoven mat of uniform density. The fibers are oriented to provide superior electrical and shielding performance. The structure of the material allows for conformability to irregular surfaces and compatibility with other base substrates or resin systems.

APPLICATION

-Microwave antennas
-EMI/RFI shielding
-Lightning strike protection
-Electrostatic finishing
-Electrostatic dissipation
-Thermal dissipation
-Radar reflective composites
-Multi-resin compatibility
-Good drapeability, conforms to irregular surfaces

SPECIFICATION

-Breathable

-Rot resistant
-Frost-proof
-Foldable
-Paintable
-Usable in walls or concrete
-Replaces reinforcement fabric
-Very easy processing even for the novice
-Length per unit: 10m or 50m
-Width: 1m
-The main advantage of RADAR, is that it provide superior penetration capability through any type of weather condition, and can be used in the day or night time.

-Radar uses electromagnetic wave that does not require a medium like Sonar (that uses water) so can be used in space and air. Radar can be long range and the wave propagate at the speed of light rather then sound (like with sonar). It is less susceptible to weather conditions compared with Lasers. And be used at night unlike passive cameras. It does not require target cooperation to emit any signals or emission.

Very flexible - can be used in a number of ways !
-Stationary mode
-Moving mode
-Two Directional mode
-Beam spread can incorporate many targets !
-Can often select fastest target, or best reflection !
-Still very reliable.

DISADVANTAGE

-Time - Radar can take up to 2 seconds to lock on !
-Radar has wide beam spread (50 ft diameter over !
-200 ft range)
-Cannot track if deceleration is greater than one !
-mph/second
-Large targets close to radar can saturate receiver !
-Hand-held modulation can falsify readings .[2]

CONCLUSION

The development of several surveillance technology has rendered obsolete textile production techniques that provide camouflage solely in the visible region of the electromagnetic spectrum. Modern military forces require counter surveillance materials that afford protection against several surveillance technology, camouflage textiles must satisfy for all threats. The ease of fulfilling such requirements varies with the substrate of the camouflage material. Conventional methods for the coloration of other fibers have been found to be inadequate. Novel dyes and pigments, as well as new techniques, have had to be developed in future.[5]

REFERENCES

[1]. Institute of Security Technologies, MORATEX".
[2]. Published by Director, DESIDOC, Metcalfe House, Delhi-1 10 054. O 1999, Defence Scientific Information & Documentation Centre (DESIDOC), Defence R&D Organisation, Delhi-110 054.
http://drdo.gov.in/drdo/pub/monographs/ Introduction/ camouflage _new.pdf
[3]. J.V.Rao and M.S.Parmar, May 2010, www.fibre2fashion.com, ´Emerging rends in Textile Materials for Personnel Protection´. The author is from the technical service department of Atul Ltd (colors division), Valsad, Gujarat.
[4]. Global Competitiveness of U.S. Military Textiles Industry Author: Dnyanada S. Satam Prepared for TTM 581: Global Textile & Apparel Marketing December 2007 http://en.wikipedia.org/wiki/Camouflage
[5]. http://www.slideshare.net/Arkatextile/military-camouflage-colours
[6]. http://www.allcamouflage.com/types-of-camouflage-2/
[7]. http://www.slideshare.net/Arkatextile/military-camouflage-colours
[8]. http://www.nhptv.org/natureworks/nwep2a.htm

[9]. Camouflage of Cotton Fabrics in Visible and NIR Region Using Three Selected Vat Dyes. http://www.kamouflage. net/article/ crypsis-3.php
[10]. http://en.wikipedia.org/wiki/Digital_camouflage
[11]. http://www.google.co.in/patents/US2004015235
[12]. Thermal camouflage tarpaulin US 20040152385 A1 http://www.ktu.lt/lt/mokslas/zurnalai/medz/medz0-97/14%20Textile... (pp.173-177).pdf
[13]. http://onlinelibrary.wiley.com/doi/10.1002/col.21778/pdf
[14]. Global Competitiveness of U.S. Military Textiles Industry Author: Dnyanada S. Satam Prepared for TTM 581: Global Textile & Apparel Marketing December 2007 http://www.textileconnect.com/documents/resources/Technical%20Textiles%20Edited.pdf