AN ELUCIDATE STUDY OF LASER TECHNOLOGY IN APPAREL INDUSTRY

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Abstract: Light Amplification by Stimulated Emission of Radiation (Laser). Lasers are being used in apparel industry from 19th century. Recently the use of laser in apparel industry is increasing in cutting garment patterns, designer cutting and engraving leather etc. Reasons for the increasing use of lasers in the apparel industry range from lowering cost to process, flexibility and even anti-counterfeiting. This review paper presents the recent advances in laser technologies with applications to the fashion and apparel industry Laser welding may be an alternative joining technique for fabrics as it enables much higher seam strengths than ultrasonic welding. Now the age of fading of denim by sandblasting is becoming older as the new technology of laser fading is replacing it .This review will concentrate on some of the new approaches in the laser technology like, 3D body scanning, pattern marking and cutting, denim fading, laser engraving, welding of garments , barcode scanning . Also goes through the hazards by the laser and their control measures. In order to successfully introduce laser in fashion there is a need for a multitude of methodologies. Areas like technologies, and a proper usage of laser, need to be combined in order to transform technology into a meaningful form of use. This paper discuss about the application of laser technology to human clothing provision and way for its implementation of this technology in the future, i.e. future direction of laser technology.

Keywords: Laser Fabric cutting and marking, denim fading, engraving, 3D body scanning, welded garment production.

Introduction

Laser light is a form of electromagnetic radiation. Lasers produce light by a process that involves changes in energy states within the atoms of certain materials. Atoms which are promoted to higher energy states release this energy in the form of light by a process called stimulated emission. The unique structure of the industry requires laser tooling that combines performance with low cost, specifically, by eliminating the high end handling systems often found on laser workstations. There are several advantages of using laser over the conventional processes in cutting, engraving, embossing, denim fading and other applications. In addition, product damage potential is reduced, no/less consumables are needed and no problem of toxic by-product disposal as found in some processes. Today's laser equipment is a result of continuous research and development of earlier products, which has undergone several changes. In the initial stage, laser systems were hard to run and difficult to maintain. However, the modern laser systems are simpler in operation and maintenance. Furthermore, the earlier systems were involved with more safety issues and needed the gasses to be constantly replenished. The garment manufactures around the globe should take the advantage of laser application in the post multi-fiber agreement regime to make their products more competitive. This review paper focuses on the technology of laser including various classifications. In addition to these it includes the applications of laser in garment manufacturing, their potential hazards and health related concerns. [3]

Applications of laser Technology

As an all-new process, there are several applications of laser technology in apparel industry. Laser engraving, cutting, marking, welding and denim fading technologies are now being widely applied and made into practice in many garment industries, fabric production units, other textile and leather industries [2]. Various applications of laser are discussed in the following section.

3D Body Scanning

The development of 3D body scanning technology allows for the quick and consistent extraction of body measurements and can generate customized fit for any number of people. As well as linear measurements, scanning can easily extract a vast number of data types and measurements relating to shapes, angles, and relational data points. For the clothing industry, scanners capture an accurate 3D representation of a garment's relationship to the body while minimizing visual distraction. The extracted measurements and the virtual picture are the foundation for individual pattern construction and digital data management. The 3D image allows instant evaluation regarding validity of the scan, the dimensions and shape data could be used repeatedly for various garments without the need for repeated measurement. The measurements obtained using this technology is more precise and reproducible than those obtained through the traditional, physical measurement process. Measurement data can be renewed or revised at any time. The 3D scanning technologies used for body measurement extraction on today's market are based on various systems. Although there are variability and incomparability of measurements between them, their common aim is to scientifically extract anthropometric data in a valid and reliable manner. [4]

Body scanners have significant advantages in measuring the human body compared to traditional tape measurement methods. Some present possibilities of measuring a human body without physical contact and eliminate the likelihood of invalid, unreliable and subjective measurement procedures, and vague judgments of posture. The extensive measurements and body models provide a foundation for specified batch and individual pattern construction based on accurate body measurements, thereby eliminating observer error inherent in traditional methods. In general, the uses of body models generated by 3D body scanning seem unlimited. These include: 3D shape data for avatar creation for online shopping, virtual fit trials, 3D product development, and body dimension analysis for target markets, animation and graphics, health and fitness management. For mass customization, the measurement procedure could be carried out only once but allow future re-use of stored data for new garment orders for instance. At present, it is not possible to exchange the scanned data of one body scanner with other systems, so in retail business terms consumer loyalty to the shop where the scan was undertaken increases. [1]

Challenges of 3Dbody scanning

Although the technology holds immense potential, problems still exist in 3D body scanning,

- Missing areas
- Body posture and movement
- Surface texture
- Body landmarks

Fig. 1 3D body scanning by Laser scanner

Laser marking

"Laser marking" refers to marking or labeling of work pieces and materials with a laser beam. In this regard, different processes are distinguished, such as engraving, removing, staining, annealing and foaming. Depending on the material and the quality requirement, each of these procedures has its own advantages and disadvantages. Laser can also be used in marking on various surfaces. The advantages of laser marking includes fast, high precision and clear marking on products of varying contour and hardness. It can also be used for a wide range of organic polymers where precession can be obtained even with complex and minute designs. Laser marking is durable and reliable so it can be applied in clothing, leather and metals. Laser marking is considered to be the best choice for branded clothing and marking fashion accessories during processing. [2]

Laser cutting

After they were introduced in the 19th century, the fashion designers and manufacturers are widely adopting laser cutting in garment manufacturing. In synthetic fabrics, laser cutting produces well-finished edges as the laser melts and fuses the edge, which avoids the problem of fraying produced by conventional knife cutters. Furthermore, use of laser cutting is increasingly used for leather due to the precision of cut components. In fashion accessories such as jewelry, laser cutting can be used to produce new and unusual designs to produce a fusion of apparel design and jewelry style. In laser cutting a laser is used to cut the fabric into the desired pattern shapes. A very fine laser is focused on to the fabric surface, which increases the temperature substantially and cutting takes place due to vaporization. Normally gas lasers (CO_2) are used for cutting of fabric. The cutting machine includes a source of laser, a cutting head fitted with mirrors to reflect the laser beam to the cutting line, a computer system to control the entire system and a suitable mean for removing the cut parts. The application of inert gases (N_2, He) during cutting prevents the tearing and removes debris and smoke from the cutting area. Like the mechanical cutting devices, a laser beam does not become blunt and does not need sharpening. Automatic single ply laser cutters are faster (30–40 m/min) than automatic multiple ply knife cutters (5–12 m/min). However, while cutting multiple plies, knife cutters are faster per garment cut and also cheaper. [2]

Fig. 2 A laser-cutting machine

Laser engraving

In laser engraving laser is used to mark or engrave an object. The process is very complex, and often computerized systems are used to drive the laser head. In spite of the complexity, very precise and clean engravings can be obtained with high rate of production and accuracy. The technique does not involve physical contact with the engraving surface, hence, no wear and tear is subjected to the fabric. The marks produced by laser engraving are clean, crisp and permanent. In addition, lasers are faster than other conventional methods used for product imprinting, which provides greater versatility in material selection. One machine can be used to cut through thin materials as well as make engravings on them. Laser engraving is used to engrave the printing screens, for hollowing, for creating pattern buttons, to engrave leather, denim etc. Pictures, flower patterns and even personalized signatures can be engraved on leather shoes, leather bag, wallet, leather belt, and leather sofa and leather clothes, greatly increasing the added value of products. In addition laser engraving is used to create embroidered pattern in the fabric by color fading and burning the fabrics. The low cost sealed CO_2 lasers are preferred for laser engraving. Laser engraving is the practice of using lasers to engrave or mark an object (it is also sometimes incorrectly described as etching, which involves the use of acid or a similar chemical). The technique is very complex, and often a computer system is used to drive the movements of the laser head. Despite this complexity, very precise and clean engravings can be achieved at a high rate. The technique does not involve tool bits, which contact the engraving surface and wear out. This is considered an advantage over alternative engraving technologies where bit heads have to be replaced regularly. Laser engraving produces a mark that is crisp, cyan and permanent. Lasers are also faster than many conventional methods of product imprinting, providing greater versatility in material choices. [5]

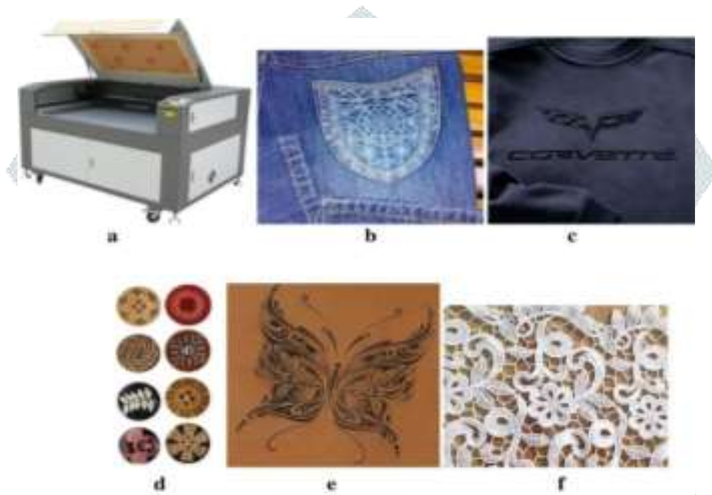

Fig. 3 Laser engraving items: a) Engraving machine, b) Denim, c) Garment, d) Buttons, e) Leather and f) Embroidery

Laser based denim fading

Now the age of fading of denim by sandblasting is becoming older as the new technology of laser fading is replacing it. In laser fading, a computer drives the laser beam to the material where marking or fading is required. The laser beam decomposes the dye and the resulting vapors are vented away. The material fades only where the beam impacts on the fabric. Commercially two types of lasers are being used: solid based and gas based. The desired degree of fading depends upon the wavelength, power density, and pulse width of the laser beam. The method of marking or fading by laser is more environmental friendly as compared to acid washing or sandblasting. [1]

Fig. 4 Denim faded by laser

Welded garment production

Welding is an alternative process of joining fabrics for garment production where the thermoplastic materials are joined together by the application of heat. The heat can be supplied by ultrasonic or by high powerful laser. The welded garment though weaker than the sewn counterpart, gives better appearance as it does not contain bulky seam and is more flexible than it. [6]

Bar code scanning

The scanners used to scan the barcodes for product identification typically uses helium– neon (He–Ne) lasers. The laser beam bounces out of a rotating mirror while scanning the code. This sends a modulated beam to a computer, which contains the product information. Semiconductor based-lasers can also be used for this purpose. However, some of the recent manufacturers are using Radio Frequency Identification (RFID) based tags instead of barcodes due to certain advantages. The RFID tag can be processed quickly and it avoids the physical handling of the product as in barcode systems. [1]

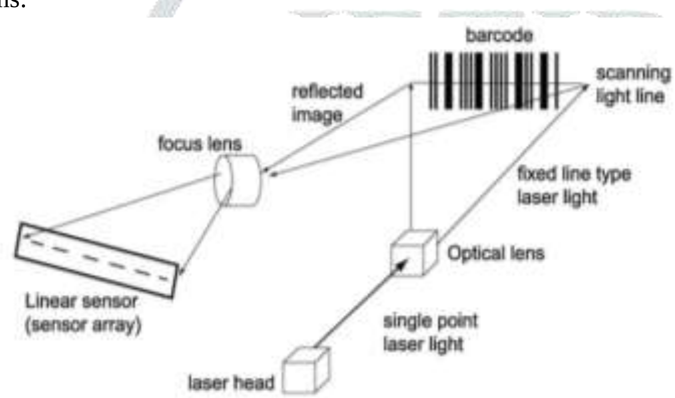

Fig. 5 A laser bar code scanner

Laser classification based on hazards

Since the early 1970s, lasers were being further classified into four classes and some subclasses depending upon their wavelength and maximum output power. This classification was based on the severity of the damage to a person when exposed to laser. These classes can be from 1 to 4. A Class 1 laser is absolutely not dangerous when used, whereas the Class 4 laser is the most dangerous. The existing system was the revised system since 2002, prior to that the old system was used. In the new system amendments have been done to certain types of lasers having a lower hazard than mentioned in the old system. Lasers are classified based on the output power in a specific wavelength, It is essential the correct information on laser class, potential hazards and safety instructions are specified by the equipment manufacturers. In the classes' 1–4 laser, there are the sub-classes 1M, 2M, 3A and 3B. The new system currently in use (shown in Table 1) uses Arabic numerals (1–4), whereas it was classified with Roman numerals (I–IV) in the old system

Table 1: The new system for laser classification

Laser class	**Features**
Class 1	The Class 1 laser is the safest under normal use. These lasers may pose a risk when viewed with a telescope or microscope of sufficiently high aperture
Class 1M	The Class 1M laser is safe during normal use. However, when passed through a magnifying device such as a microscope can pose hazard. A laser falls in this class if the power that can pass through the pupil of a naked eye is lower than the accessible emission level (AEL) for Class 1
Class 2	A Class 2 laser is the visible-light laser (400–700 nm). It is safe as the blink reflex will limit the Exposure time lower than 0.25 s. However, intentional holding of the blink reflex

	could lead to Potential eye injury. Several measuring instruments and laser pointers are based on Class 2
Class 2M	This class laser is safe as the blink reflex if not viewed through optical instruments. Similar to Class 1M, this class laser lights are with a large divergence, the light passing through the pupil should not exceed the specifications for Class 2
Class 3A	This laser class is safe if handled carefully. The maximum permissible exposure (MPE) can be exceeded, which is associated with a low injury risk
Class 3B	This class is hazardous if exposed directly to the eye. Protective eyewear must be used where direct Viewing is needed or may occur. The equipment with Class 3B lasers must be fitted with a safety interlock and a key switch
Class 4	This class is the most dangerous among all lasers. This laser can cause permanent eye damage or burn the skin as a result of direct, diffuse or indirect beam viewing or contact. These lasers may cause a fire risk as they can ignite combustible materials. Several laser used in scientific, industrial, military and medical applications fall in this category. The equipment with Class 4 lasers must be fitted with a safety interlock and a key switch

Hazards by laser and their control [1], [2]

Electrical shock

More people are being killed by electrocution from the laser electronics than blinded from exposure to a laser beam. Lethal voltages are present in the power supplies of lasers. If one is not experienced working with high voltages in general and laser power supplies in particular, then the person should not be allowed to carry out any work with the laser. During maintenance of the laser, the power supply should be unplugged from its electrical outlet**.**

Eye injury

Eye is the most vulnerable body part to a laser beam. With certain lasers severe damage can be caused due to the high concentration of laser energy on retina. Class 4 lasers can damage the tissues in the eye interior. The class and duration of laser exposure are the deciding factors in the eye injury. For example, no injury is been expected while working with the laser with wavelength in the visible spectrum (400–700 nm). Lasers of Class 3B or Class 4 can lead to an eye injury before the aversion response can protect the eye. Various types of laser hazards and precautions to be taken as specified by American National Standards Institute (ANSI) and Occupational Safety and Health Administration (OSHA).

Skin injury

The injury to the skin due to laser radiation is less severe compared to the eye. However, the chance of exposure of skin is higher than that of the eye due to its greater surface area. The eye injury is more significant than the skin as the loss in the vision is irreparable. In normal laser working condition there is very less chance that a large area of the skin is exposed.

Control measures [1], [2]

The objective of hazard control methods is primarily stopping the laser contacting the skin or entering into the eye. These control methods can be grouped into three sections of controls such as: (a) administrative controls [labels, signs, standard operating procedures (SOPs), etc.], (b) engineering controls (barriers, blocks, etc.) and (c) protective controls (eyewear, uniform, etc.).

Administrative controls

The management should only allow the trained persons to work on laser equipment. The operator should follow the instructions as in SOPs. The laser equipment should be switched off while not being used. All laser equipment of Class 3B or Class 4 lasers need to be labeled with "Danger" symbol, specifying the laser class. A Class 3B laser device should mention "laser radiation-avoid direct exposure to the laser beam", which must be written above the tail of the sunburst. A Class 4 laser device should mention "laser radiation-avoid eye or skin exposure to direct or scattered radiation".

Engineering controls

The possibility of accidental exposures to laser hazards can be best controlled by engineering controls. The laser systems can be fitted with key switches or password protected for better safety. In the laser chamber, the setting should guarantee no direct eye most hazardous aspect of laser use is the beam alignment of it, where most eye injuries occur. Hence to avoid this, the instructions contact. The described in the SOP must be understood. The lowest visible beam power should be used for beam alignment.

Protective equipment controls

The user of laser equipment should wear appropriate personal protective clothing and a proper device for eye and skin protection during initial setting as well as the normal working. The skin covering and the eyewear protects the skin and eye, respectively from direct exposure of laser.

Conclusions and Future Directions

Laser technology can be used for various applications on materials ranging from metals to textiles with non-contact patterns. In garment production, it can be applied onto different products ranging from home textiles to fashion accessories. In garment manufacturing, CO_2 gas lasers have wide and successful applications. Laser technique, is entirely different from traditional textile processes, as it has the flexibility in design and operation without any pollution or waste material. There are several other advantages of using laser over the conventional methods in cutting, engraving, embossing, denim fading etc. In addition, laser involves lower risk of product damage, use of low consumables and free from disposing of toxic by-products, as there may be with some methods. The laser equipment of today has gradually evolved from those used in early days. The old laser equipment were difficult to run, and hard to maintain. However, the modern equipment are easy to operate, simple to learn and easy to maintain. [7]

Human beings have always been concerned about how their clothes look and fit. Finding just the right outfit in the style and color that makes them look their best is one thing, but finding the perfect fit can add hours to their shopping experience. Exploring new technologies for managing and improving consumers' experiences and satisfaction is important in today's competitive retail environment. Mass-produced clothing will also be improved as a result of applying body scanning technology. Industry and academic researchers are beginning to use large amounts of anthropometric data captured by body scanners to adjust the sizing systems of ready-to-wear clothing in order to attain better fit. Beyond measurement, analysis of data is determined by the objectives of the measurement. It is evident that data from body scanning could be used for diverse needs in the clothing industry. Like made-to-measure, customization, fit trials, developing standardized size for specific targets, creating niches, efficient communication during manufacturing processes, efficient and rapid prototyping and online shopping. It is anticipated that many more opportunities for creative collaboration will be explored as 3D laser scanning receives increased exposure through dissemination of research and innovative product development.

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