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# Potential Benefits of adoption of Laser Materials Processing in East Africa's Manufacturing Industry

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## Abstract

Laser technology is applied in a wide range of applications in various sectors, including industrial manufacturing, medical, and communication, among others. The laser is a versatile tool for materials processing as it is a non-contact tool that is CNC programmable and can be utilized in various industrial production processes. One of the most important and unique features of laser radiation is that it can be focused into a microscopic spot size generating high power densities in tens MW/cm<sup>2</sup> that are capable of melting and vaporizing metals at fast rate yielding high speed production processes. Different types of laser sources - differing in features such as operating wavelength, maximum output power, beam quality, and method of beam delivery - are now widely deployed in specific applications with realization of benefits in process performance and product quality. The laser characteristics that benefit various laser materials processing applications include kilowatt output power, high beam quality, fiber optic beam delivery, and small footprint (compact laser systems). Lasers are used in the manufacturing industry for materials processing applications such as cutting and welding of metals, surface hardening and cladding of metals, joining of plastics, marking/engraving, drilling/micromachining, etc. Equipment manufacturers often use the laser in production processes such as profile cutting and welding of metals; the laser is often utilized in profile cutting of sheet and plate metal whereby a large number of parts are nested to improve material usage and avoid wastage. The laser is also used for maintenance and repair works involving surface hardening and surface cladding of worn out machine components. Uganda and Kenya have recently started to exploit their oil deposits and there are prospects of industrial growth in the region to service the oil sector as well as other sectors that will benefit from the oil proceeds. Large multibillion-dollar infrastructure projects - such the Standard Gauge Railway, SGR, the Lamu Port, Southern Sudan-Ethiopia Transport Corridor, LAPSSSET and Uganda-Tanzania oil pipeline – are also underway in the region. Consequently, East Africa's manufacturing industries need to position themselves to meet the stringent demands for high quality equipment and machinery for the oil and gas industry as well as meet the maintenance requirements of such an ultramodern infrastructure. The process benefits that will be realized from utilization of laser technology in East Africa's manufacturing industry include high productivity through high processing speeds, reproducibility of high product quality, and flexibility of manufacturing as the same laser source can be used for different production processes.

**Key Words:** Laser Technology, Laser materials processing, Cutting, Welding, Micromachining, Surface Hardening, Surface Cladding

## 1.0 Introduction

The East African Community (EAC) is a regional intergovernmental organisation of 6 Partner States: the Republics of Burundi, Kenya, Rwanda, South Sudan, the United Republic of Tanzania, and the Republic of Uganda, as shown on the map in Fig. 1, with its headquarters in Arusha, Tanzania. The EAC is home to 150 million citizens, of which 22% is urban population; with a land area of 1.82 million square kilometres and a combined Gross Domestic Product of US\$ 146 billion (East African Community Secretariat, 2016), the realisation the renewed and reinvigorated EAC bears great strategic and geopolitical significance and prospects. The EAC aims at widening and deepening cooperation among member states in key spheres of national development, namely political, economic and social for mutual benefit of member states. (East African Community, 2016). Consequently, the national development strategies of each of the member states of the EAC have identified the manufacturing sector as one of the top priority areas for socio-economic transformation due to its potential to create jobs, generate foreign exchange, and attract foreign direct investment (Complete Vision Burundi 2025; Kenya Vision 2030; Rwanda Vision 2020; Uganda Vision 20140; and The Tanzania Development Vision 2025).



**Fig. 1.** A map of the East African Community ([Domestic Tourism Safaris Home](#))

The manufacturing sector is sub-divided into several sub-sectors including: food processing, and beverages (agro-industrial), refined petroleum products, textiles apparels and footwear, forest products, chemicals, machinery and equipment production, metal fabrication, rubber and plastics, furniture, etc. To meet the desired development goals and in an effort to raise productivity per unit of input (labor and capital) closer to international competitors, the manufacturing sector is expected to become more efficiency-driven by use state-of-the-art technology that is both efficient, cost-

effective and environmentally-friendly. Consequently, the machinery and equipment production and general metal fabrication sub-sectors are expected to play a vital role in stimulating and boosting growth in other manufacturing sub-sectors through provision of the necessary high quality, efficient machinery and equipment. However, the machinery and equipment fabrication sub-sector is almost inexistent and this makes it difficult for the manufacturing sector in EAC member states to play a larger role in their economies. The factors that have contributed to the lack of competitiveness in the metal fabrication sub-sector include the inexistence of basic steel metallurgy industry, high input costs for imported raw materials, high cost and unreliable energy supply, lack of skilled labour, low quality products, low productivity levels compared to global productivity levels, inefficient flow of goods and services; and unfavourable business environment that is not conducive for investment in capital-intensive industries such steel production.

Laser technology is used worldwide in the areas of industrial manufacturing (i.e. laser material processing), communications, medical, lithography, optical Storage, military, R&D, Instrumentation, and Sensors, displays and printing. A high power laser is a CNC programmable versatile tool that is utilized in various industrial production processes - such as cutting, welding, surface treatment, marking, etc - resulting in an efficient non-contact automated process that produces high quality products. Different types of laser sources - differing in features such as operating wavelength, maximum output power, beam quality, and method of beam delivery - are now widely deployed in specific applications with realization of benefits in process performance, cost and product quality. The leading commercial types of lasers used in materials processing applications include: carbon dioxide (CO<sub>2</sub>) laser, Nd-YAG laser, ytterbium (Yb) doped fiber laser, ytterbium (Yb) doped disk laser, and high-power diode lasers (Steen, 2003; Schopphoven, 2017; Ready 2001).

Laser technology in communications has been adopted in East Africa through the extension of the optical fibre networks that are being widely deployed by the telecommunications companies in the region. However, laser technology in manufacturing industry is not widely used in East Africa's industrial activities. Consequently, this paper explores potential laser applications prospects in East Africa's industrial manufacturing industry and the associated benefits that can be realized. The objective of this paper is to highlight the potential benefits of laser technology in East Africa's manufacturing sector and initiate an intellectual discussion on the role of laser materials processing in contributing to improving the global competitiveness of the nascent East Africa's manufacturing sector.

## **2.0 Types of Lasers Used in Manufacturing Industry**

Lasers are used in the manufacturing industry in materials processing applications such as cutting and welding of metals, surface hardening and cladding of metals, joining of plastics, marking/engraving, drilling/micromachining, etc. Some of the laser characteristics that benefit the various laser materials processing applications include kilowatt output power, high beam quality, fiber optic beam delivery, and small footprint (compact laser systems). The common commercial

lasers for materials processing include: CO<sub>2</sub> laser, Nd: YAG laser, fiber laser. Diode lasers are based on semiconductors (e.g. GaAlAs, InGaP, etc.) and emit light beam over spectral range of 375nm to 1600nm wavelength depending on the semiconductor compound material used; the main industrial application of diode lasers is pumping of other solid state lasers but they are increasingly also being directly used in materials processing applications (Belforte, 2014). Commercial lasers compete in the materials processing marketplace in terms of their operating wavelengths, maximum available output power, efficiency, technological improvements and designs, and new application prospects.

## 2.1 CO<sub>2</sub> Laser

The CO<sub>2</sub> laser emits a far infrared laser radiation of 10.6 μm wavelength and has overall efficiencies up to 30%. The different designs of the CO<sub>2</sub> laser - transverse flow (cross-flow) laser, fast-axial flow laser, diffusion-cooled slab laser and sealed-off laser, use different modes of gas flow and cooling, different orientations of the discharge electric field and gas pressure levels. This enables effective CO<sub>2</sub> laser beam outputs over a wide range of output power in CW mode or pulsed mode. The output power level that can reach tens of kW and the beam quality of the CO<sub>2</sub> laser is favorable for thin to thick section metal cutting and welding applications (Whitehouse, 1993; Anon, 2003, 2005; and Ready and Farson, 2001).

## 2.2 Nd: YAG Laser

The Nd: YAG laser is a solid-state laser consisting of a synthetic single crystal of yttrium-aluminum-garnet (YAG) that is doped with a low percentage of the rare earth neodymium (Nd<sup>3+</sup>) ion and emits near-infrared laser radiation at a wavelength of 1.064 μm. Unlike CO<sub>2</sub> laser, the output beam quality of the Nd:YAG laser can be affected by the thermal lensing effects caused by variation in the optical characteristics of the YAG crystal rod with increasing output power which limits the output beam quality at high power levels. Nevertheless, the Nd:YAG laser finds wide application in sheet metal cutting of complex geometries especially in highly reflective sheet materials (Whitehouse, 1993; Kugler, 2001; and Ready and Farson, 2001).

## 2.3 Fiber Laser

The ytterbium fiber laser - operating at near-infrared spectral range (1060 – 1080 nm) - is a cladding-pumped optical fiber laser delivering a unique combination of kilowatt power output, high beam quality, and high wall plug efficiency; thus the fiber laser offers increased performance flexibility in materials processing applications than realized by the more traditional solid-state Nd:YAG laser (IPG Photonics, 2010; O'Neill, 2004; Canning, 2006). IPG Laser GmbH, a subsidiary of IPG Photonics Corp, provides high-brightness short pulsed lasers of up to 1 kW and CW lasers up to 10 kW average power in compact systems. IPG single-mode fiber lasers with outstanding wall-plug efficiencies of 40 % are delivered in compact 19" racks for YLR series up to 2 kW and in cabinet systems for the YLS series up to 10 kW are delivered (Streek, 2017). The high brightness fiber laser - with its combination of high beam quality and kilowatt power output coupled with its additional beneficial attribute of lower wavelength than the CO<sub>2</sub> laser - is now challenging

the CO<sub>2</sub> laser in heavy industry laser materials processing applications. The fiber laser market is expanding due to its advantages in materials processing such as higher efficiency, higher beam quality and the ability to process highly reflective material (such as copper and copper alloys) which are difficult to process with the CO<sub>2</sub> laser due to the high reflectivity and lower absorption of metals at CO<sub>2</sub> laser wavelength (Keller, 2017; Kliner, 2016)

### **3.0. Production Benefits of Laser Technology in Manufacturing Industry**

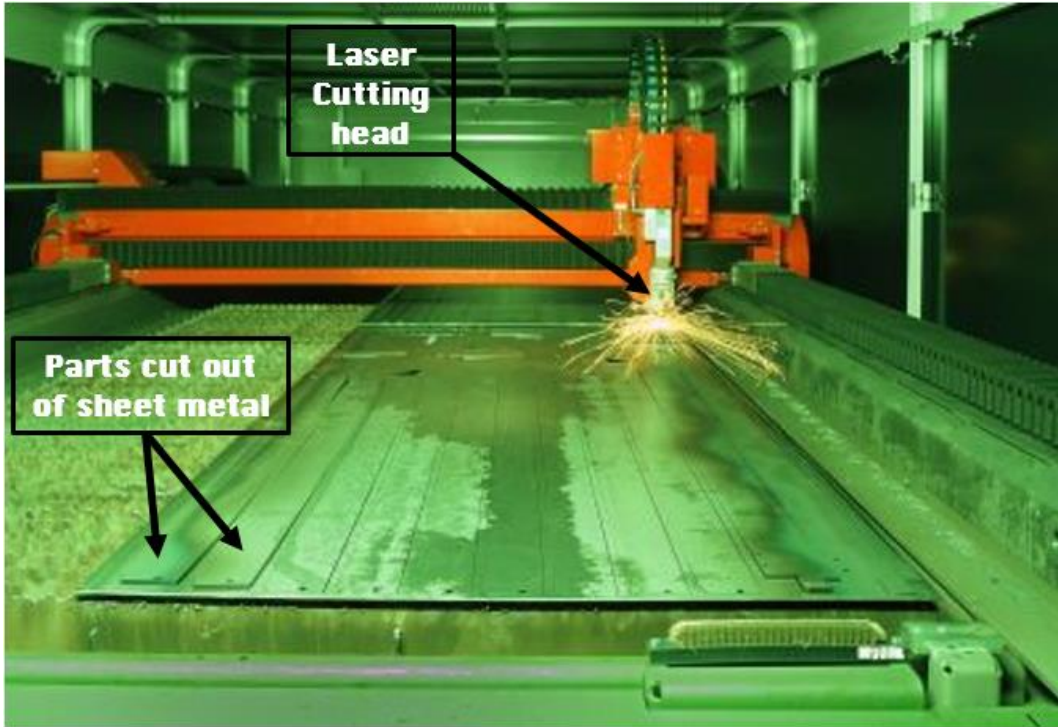
The laser is used in various processes in manufacturing industry including sheet metal cutting, metal welding, and creation of wear resistant surfaces on components by surface treatment and cladding. Laser materials processing is a non-contact CNC controlled process that is integrated with the CAD and can be rapidly utilized in production of original parts and spare parts through rapid prototyping and also production of re-engineered spare parts through reverse engineering.

#### **3.1. Production Benefits in Laser Cutting**

Sheet metal cutting is an important process in the manufacture of many everyday products, such as household items like fridges, cookers, furniture; transport vessels like aircrafts, ships, cars, railways; industrial equipment and machines, etc. (Ion, 2005; and Ready and Farson, 2001). Traditionally, cutting of contours in the sheet metal is achieved by either mechanical cutting by use of mechanical tools to shear through the metal material or thermal cutting by use of a heat source (a flame or arc or beam) to melt the metal in a localized zone followed by removal of the melted material to create a cut. Sheet metal cutting using mechanical tools - e.g. power press or shear cutter - causes tool wear, deformation of delicate workpieces, dimensional inaccuracies, and generation of noise. Meanwhile, thermal cutting using conventional thermal energy sources - oxy-acetylene flame cutting or plasma arc cutting (PAC) - has shortcomings of excessive heat buildup in the workpiece which induces thermal stress in the workpiece resulting in distortions and unfavorable alteration of microstructure in the vicinity of the cut with subsequent undesirable modifications in material properties. Additionally, the thermal cutting using conventional thermal energy sources are limited in achievement of the actual dimensional tolerances. Laser beam cutting is a thermal sheet cutting processes that is capable of creating complex geometries in various metallic materials and attain stringent design dimensional tolerances in a wide range of workpiece thickness with negligible heat buildup in the workpiece. The various commercial laser technologies - including CO<sub>2</sub> laser, Nd:YAG laser, ytterbium (Yb) doped fiber laser, and ytterbium (Yb) doped disk laser - are widely used in sheet metal cutting. The performance of the laser cutting process is influenced by a number of laser cutting parameters that can be optimized to obtain a good cut quality at maximum processing speeds (Sparkes, 2008; Sparkes, 2006; Himmer, 2007; Mahrle (2008), Wandera<sup>a</sup> and Kujanpää, 2010; Wandera<sup>b</sup> and Kujanpää, 2010; Wandera and Kujanpää, 2011; Wandera *et al.*, 2011; Wandera *et al.*, 2009). Thin to thick section precision cutting of various profiles in making components parts out of sheet and plate metal improves versatility in production of high quality equipment for the automotive industry, agro processing and increased production lead times.

David Larcombe reported that the UK based factory of trailer manufacturer, Indespension, has doubled their sheet metal cutting productivity by replacement of a CO<sub>2</sub> laser-powered cutting machine with a 4kW fibre laser powered profiling centre having a 6.5 × 2m capacity bed (shown in Fig. 2) and costing approximately \$1.3 million. Indespension's factory cuts mainly mild steel, and some aluminium, from 1mm to 12mm thickness and the fibre laser reportedly cuts three times faster than the CO<sub>2</sub> laser of equivalent capacity for up to 3mm sheet thickness. The fibre laser speed advantage reduces as the sheet thickness increases but overall the fibre laser cuts twice as fast as the CO<sub>2</sub> laser across all the sheet gauges processed thus enabling Indespension to manage their ever-increasing laser cutting workload. Investment in laser cutting enhances in-house control over production, saves expenses of subcontracting sheet metal work; and streamlines the design and prototyping process during product development and design change/modification enabling faster introduction of new products to market by reducing the lead time and costs for introducing a new or a modified product (Larcombe, 2017).

Laser-cut features are used extensively in trailer assembly and there are several benefits of incorporating laser machining in trailer manufacture. The laser machining process is so fast and accurate so that laser machined components fit together precisely and quickly during assembly without the need for time-consuming fitting-up. Laser machining also enables a cost-effective way of reducing weight of components by incorporating numerous holes and slots (see Fig. 3) which would be too labour-intensive and uneconomical when done manually. Furthermore, laser machining allows nesting of similar parts or even different component parts within the same sheet when the sheet gauge for the parts is the same and allows a wide range of component sizes to over 5.8m. The operator can use a manual, suction-pad lifting system (shown in Fig. 4) for sheet metal handling when loading blanks onto the shuttle cutting table or off-loading large size components. The laser machine control software contains 3D CAD/CAM functionality so a cutting program can be generated with full simulation capabilities, nesting of the maximum number of parts on a sheet, creation of cutting plans, and provision of an overview of the manufacturing process - including access to production and machine data - thus providing an increase in production capacity (Larcombe, 2017). The lasers are also used in creating slotted steel pipes used in the oil industry for oil exploration and heavy oil production whereby the laser cutting enables fast and easy piercing with high dimensional accuracy in creating slots in the steel pipes as illustrated in Fig. 5. Heavy oil is relatively viscous and contains a significant amount of sand and gravel particulates. Therefore, the slotted steel pipes are used to line parts of a drilled oil well in the production zone so that oil flows through the slots into the pipe and up to the wellhead and the slots act as a sieve to exclude about 95% of the particulates (see Fig. 5) (Rath and Gaebler, 2017).



**Fig. 2.** Laser Cutting Workstation (Larcombe, 2017)



**Fig. 3.** Trailer body with sheet metal component parts having laser-cut holes and slots (Larcombe, 2017).



**Fig. 4.** A suction-pad lifting system for manually transferring sheet metal on and off the laser cutting shuttle table (Larcombe, 2017).



**Fig. 5.** A slotted steel pipe used in the oil industry for heavy oil production; the slots are created by laser cutting (Rath and Gaebler, 2017).

### **3.2. Production Benefits in Welding**

The predominant use of laser welding in the automotive manufacturing industry is enhanced by the many benefits of laser welding such as high speed, high productivity, creation of very deep and narrow welds and low heat input leading to small heat affected zone and low residual stresses. During the laser welding process, changes in process parameters can affect the size and properties of a welded joint which effects may compromise the mechanical behavior of the welded component leading to failure in performance; therefore, monitoring and controlling the laser welding process ensures the quality of the weld. Lessmüller Lasertechnik in Germany has reported of an Optical Coherence Tomography (OCT) sensor 3D measuring system for real-time seam tracking during laser welding to enable consistent and high quality welds by facilitating laser beam positioning, process monitoring, and quality control with the required precision (Dupriez , 2017)

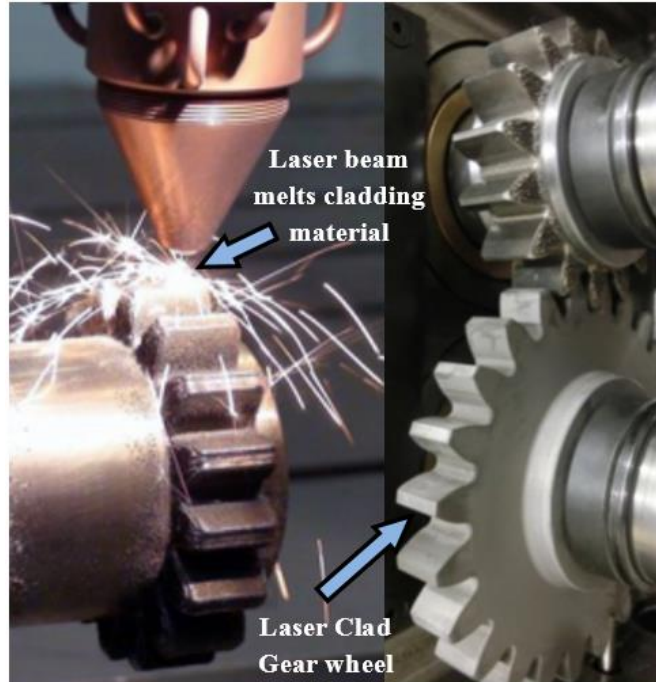
### **3.3. Production Benefits in Application of Wear Resistant Surfaces**

Some machine components wear out while others corrode; therefore, refurbishment of worn machine parts by applying special coatings is an important procedure in operational and repair industries. Machine components operating under combined action of wear and corrosion as well as high temperature operating environment are usually refurbished to improve their wear and corrosion resistance. Various surface treatment methods - involving the use of heat to change the metallurgical properties of the surface - are used to improve the hardness, strength and fatigue life of components and also reduce friction and wear of parts by selective surface hardening. Some of the processes used to modify the surface properties of components, include: surface heat treatment, surface alloying, surface cladding, surface melting, surface texturing, etc (Ion, 2005). Cladding is a process for applying wear-resistant and corrosion-resistant metal coatings on machine components that are prone to wear and corrosion. The aim of the cladding operation is to produce a clad layer by overlaying a substrate metal with another metal (cladding metal) by forming a sound interfacial bond or weld between the two metals but without diluting the cladding metal with the substrate metal. During the cladding operation, the degree of mixing of the filler material with the base material has a significant impact on the chemical composition of the surface layer and its resulting mechanical properties. The presence of a significant amount of the base metal in a cladding layer leads to a reduction of the desirable operational (functional) properties - such as wear resistance and corrosion resistance - of the modified surface layer thus multiple layers of the coating material often must be applied if much of the coating material mixes with the base material. Therefore, the depth of fusion of the base material with the filler material should be regulated; the mixing ratio - represented by the ratio of area of molten underlying metal to the area of the entire molten metal in the fusing cross section - must be limited (Kargapoltsev, 2017).

Laser cladding of a component surface involves production of a wear resistant and corrosion resistant surface layer by introduction of a high quality powder filler metal under the action of a laser beam. Laser cladding is an innovative cladding technique applicable to a diverse range of metal alloys with quality and high speed benefits resulting in cost savings due to increased productivity and reduction in the cost of the clad layers. Laser cladding can be used for applying

wear-protection coatings on large and small rotating parts by fusing metal powder on existing metal components under action of a directed laser beam such that the applied wear-resistant coating layer is metallurgically bonded to the underlying material with optimal adhesion but minimal structural intermixing. Wear resistance of surface layers formed by the laser cladding method exceeds the wear resistance of surface layers formed by other cladding methods, e.g. gas-flame melting, chrome plating, or high-velocity oxygen fuel spraying (thermal spraying), due to the specific conditions of crystallization and formation of a fine structure during the laser cladding process. Additionally, the efficiency and wear resistance of surface details renovated with the help of laser cladding have been shown to exceed those of new surface details causing a reduction in labor costs for subsequent repair and improvement of reliability of the machines. The laser cladding method produces a high quality clad layer, reduces the amount of high-quality filler metal used for cladding the component surface and also significantly reduces the labor costs for production of spare parts. (Kargapoltsev, 2017)

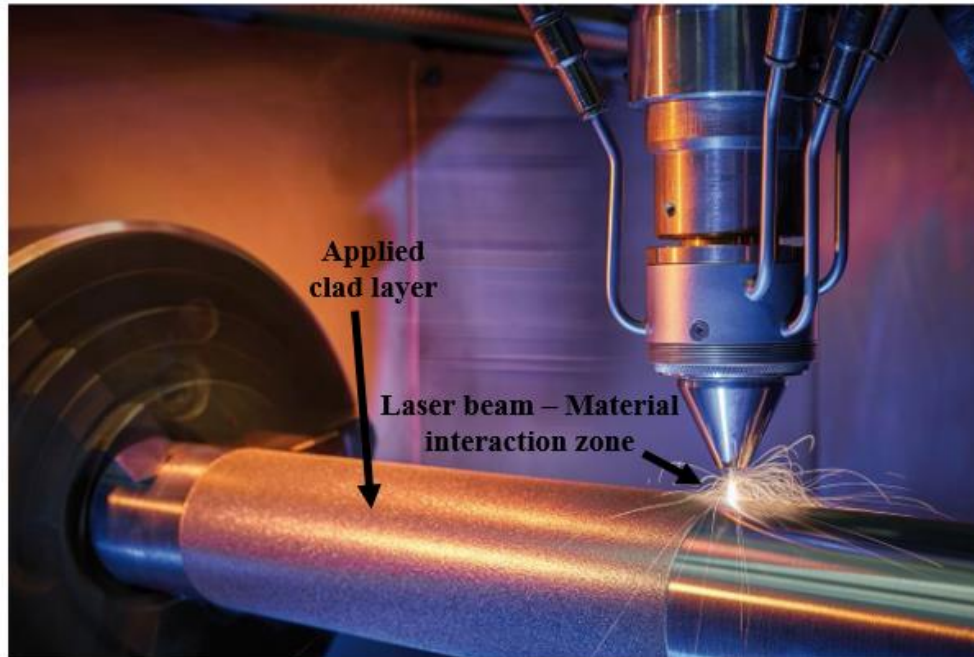
High-speed laser cladding having a capability to reliably apply a coating on a metal component clamped on a lathe machine is a cost-efficient alternative to the more conventional cladding techniques such as chromium, flame spraying, and hard-facing. The melting process in laser cladding is optimized using enhanced optics and vision systems to monitor clad geometry, metallurgical properties, and temperature information in order to develop superior coating adhesion. Additionally, laser cladding is suited for rotating parts which are clamped on a fast rotating lathe and coated with chosen metallic layer to produce high quality coatings that increase the lifetime of components that are susceptible to wear. Typical laser cladding applications include application of clad layers on axles, shafts, bearings, tubes, crankshafts, rollers, wheels, etc; and typical cladding materials include nickel, stellites, and stainless steel alloys, with or without carbides. A state-of-the-art high-speed laser cladding installation can apply coatings on components up to 10m and 3500kg for diameters below 120 mm and up to 4m and 750kg when the diameter exceeds 120mm. Some examples of applications laser cladding in industry include 3D printing of gears in gearbox prototyping as reported by automotive supplier VCST in Belgium (see Fig. 6), and laser cladding of extrusion screws for pet-food manufacturing by Vatis (See Fig. 7) extends the lifetime of the extrusion screws by up to 300% compared with conventional hard-facing methods thus enabling considerable savings on maintenance and investment costs (Laser Cladding Venture, 2017). Researchers from the Fraunhofer Institute for Laser Technology ILT and RWTH Aachen University in Germany have reportedly developed an extremely high-speed laser material deposition process (known by its German acronym EHLA) that is economical and eliminates drawbacks of conventional chrome plating or thermal spraying techniques; the EHLA process that permits high processing rates of 250 cm<sup>2</sup> per minute is shown in Fig. 8. Laser material deposition allows for far thinner layers (between 0.5 and 1 millimeter) since laser material deposition requires considerably lower heat input compared to conventional processes (Schopphoven , 2017)



**Fig. 6.** 3D printing of gears through laser cladding enables development of automotive gearbox concepts (Laser Cladding Venture (LCV), 2017).



**Fig. 7.** Laser cladding of pet-food granulate extrusion screws extends screw lifetime (Laser Cladding Venture (LCV), 2017)



**Fig. 8.** Coating of a piston rod using the EHLA process (Schopphoven, 2017)

#### **4.0 East Africa's Industrial Development and Prospects for Laser Technology**

##### **4.1 Automotive Manufacturing Industry**

Africa's automotive industry is expected to experience transitions in many countries, notwithstanding the slower economic growth rates in Africa in 2016 due to sustained lower oil and commodity prices. As key industries begin to emerge as drivers of Africa's economic growth and East Africa is emerging as the fastest growing region on the continent, the opportunities for Africa's automotive industry are looking increasingly attractive. In sub-Saharan Africa cities where the automotive market is relatively new and vehicle ownership still seems to have an aspirational value when compared to that of more mature European and American markets where car ownership concepts in congested cities is changing to car-pooling and ride sharing. Although Africa's automotive industry is relatively underdeveloped in comparison to Europe, Asia and North America, the improvements in local manufacturing, infrastructure development, and economic growth are increasing the continent's industrial prospects (Parker, 2017). Automotive manufacturing industry has a strong job multiplier effect in industry as research has shown that every automotive manufacturing job creates up to seven additional jobs (Centre for Automotive Research, 2015). It is also known that economies with established automotive sectors tend to be more economically complex in terms of the measure of knowledge translation into products made in the society resulting in more prosperity (Centre for International Development, 2016)

Kenya - with her growing economy, physical position and regional market access within the East African Community (EAC), and history of automotive assembly industry - is well positioned as a potential automotive manufacturing hub in the East African region (Deloitte, 2017). Uganda's Kiira Motors Corporation (KMC) is an automotive industry development initiative supported by the

government through the presidential initiative on science and technology and is aimed at setting up and operating a vehicle assembly plant in Uganda ([www.kiiramotors.com](http://www.kiiramotors.com), 2017). There is demand for transportation in the various sectors including construction, mining, agri-business, tourism, energy, health, education, and retail sectors in East Africa; and government institutions in East Africa are significant buyers of new vehicles.

Although, Kenya’s automotive market is largely focused on retail and distribution of vehicles, and after-sales support in servicing and sale of spare parts, Kenya also currently has three small scale motor vehicle assembly plants, which include: General Motors East Africa (GMEA) plant in Nairobi, Associated Vehicle Assemblers (AVA) plant in Mombasa, and Kenya Vehicle Manufacturers (KVM) plant in Thika. These three motor vehicle assembly plants are operating below their capacity as indicated in Table 1; however, counties in Kenya - such as Machakos County - have been lobbying investors to set up manufacturing hubs in their regions to provide employment and promote trade within their jurisdictions. Kenya’s domestic automotive production is dominated by commercial vehicles; close to 10% of the 9,295 vehicles assembled in Kenya in 2015 were light commercial vehicles such as pick-up trucks, and the rest were heavy commercial vehicles such as trucks and buses. The motor vehicles assembly in Kenya grew by 31.4% from 2013 to 2014 with the highest growth being registered in the production of pick-ups followed by trucks and buses, respectively; and Kenya’s growth in vehicle assembly is anticipated to almost double between 2013 and 2019. (Deloitte, 2017)

**Table 1.** Automotive Assembly Plants in Kenya, 2015 (Deloitte, 2017)

Plant	Location	Installed Annual Capacity	Operating Capacity (2015)	Ownership	Brands
GMEA	Nairobi	16,000	5,015	General Motors East Africa (100%)	Isuzu
AVA	Mombasa	10,000	4,168	Marshalls East Africa (50%) Simba Colt (50%)	Mitsubishi, Fuso, Scania, Toyota, Hino, Tata
KVM	Thika	6,000	202	Government of Kenya (35%) CMC Holdings (32.5%) DT Dobie (32.5%)	Eicher, Hyundai, Land Rover, MAN, Nissan, Mobius, Ashok Leyland

The 2010 National Industrialization Policy Framework of Kenya identified the automotive and auto parts industry as a major economic driver. In order to build up the Kenyan automotive industry, the framework specified five policy statements in-line with development of an automotive industrial park, provision of incentives to encourage locally assembled vehicles and production of auto parts, establishment of a national automotive industry committee, encouraging a local industry by imposing high tariffs on automotive components that could rather be manufactured locally, and setting up a joint venture with an established automotive manufacturer with a goal of domesticating the company (Deloitte, 2017). Furthermore, in 2015, the Kenyan Ministry of Industrialization

proposed the Policy Framework for Motor Vehicle Assembly in Kenya to complement the National Industrialization Policy Framework with the aim of promoting new investments in the automotive industry and enhance Kenya's potential as a globally competitive vehicle manufacturer. The 2015 Motor Vehicle Assembly Policy Framework, like the National Industrialization Policy Framework, aims at creating a National Automotive Council (NAC) which will be equipped to address aspects relating to the assembly and manufacture of vehicles, including capacity building and implementation of proposed incentives. However, the 2015 Motor Vehicle Assembly Policy Framework is specifically centered on the automotive industry with a structure to drive local production thus differing from the 2010 National Industrialization Policy Framework which focuses on industrialization as a whole and manufacturing more broadly. Furthermore, the East African Community (EAC) - in its draft East African Industrialization Strategy 2010-2030 released in 2010 - identified Kenya as a potential vehicle production hub for the region urging major car manufacturers that already imported vehicles into the region to produce locally. However, in consideration of 20 industries, the automotive assembly and vehicle spare parts manufacture was later identified as having the least growth potential in the region and was not included in the final EAC Industrialization Strategy 2012-2032. Nevertheless, automotive industry stakeholders recognize the opportunity of both the regional parts value chain as well as the EAC as a market for regionally produced vehicles and parts.[39] Products that are substantially transformed (i.e. from Completely Knocked Down state to full assembly state) within any of the East African Community (EAC) member states - Burundi, Kenya, Rwanda, Tanzania and Uganda - are to be sold on a duty-free basis in the other member states; and EAC member states in 2009 ratified a Common External Tariff (CET) of 25% on vehicles imported into the region with the aim of driving local assembly efforts. However, implementation of the CET was put on hold so other EAC countries continue to impose duties on vehicles assembled in Kenya with Tanzania and Uganda's argument being that Kenyan assembled vehicles do not abide by Tanzania and Uganda's local content requirement of 35% and thus do not qualify for duty-free access. Consequently, vehicles imported into the region are having an advantage over vehicles assembled regionally as cars imported into Uganda and Tanzania from Japan are cheaper than vehicles assembled in Kenya. (Deloitte, 2017) Regionally accepted definitions of local content, within the EAC, needs to be developed and aligned to the member states' automotive and manufacturing policies so as to enable establishment of an East African automotive manufacturing hub and export strategy. Additionally, development and promotion of auxiliary industries in partnership with automotive manufacture and assembly enables automotive companies to locally source high-quality inputs and meet the requirement for local content which further strengthens the case for local automotive assembly and marketing.

Frost and Sullivan identified manufacturing as one of the key future industries in Africa; automotive manufacturing and assembly has considerably promising prospects in Africa as the automotive manufacturers are adopting the practice of moving to produce vehicles within the African continent. This trend is primarily prompted by the local content promotion policies of countries - like Kenya and Nigeria - that have resulted in restrictions on imports of second-hand vehicles and heavy tariffs on new imported vehicles. Furthermore, the expanding transport infrastructure projects in East

Africa are also expected to reveal greater logistics opportunities with significant increase in the demand for commercial vehicles in East Africa. (Parker, 2017)

## **4.2 Energy Sector**

Improvement of the energy distribution systems have been identified as being a very critical in strategy for boosting the economy. Uganda is in the process of developing a number of new hydro power generation dams in various sites around the country including Bujagali dam, Karuma dam, Nsimbe dams. Furthermore, Uganda and Kenya have recently started to exploit their oil deposits and there are prospects of industrial growth in the region to service the oil sector as well as other sectors that will benefit from the oil proceeds. Tanzania has also developed their Natural Gas Utilization Master Plan 2016-2045 as an integral part of the strategy for the implementation of the National Energy Policy 2015 which provides guidance on the utilization of the resources for improvement of infrastructures and human capital development in Tanzania. Consequently, the manufacturing sectors in these East African countries need to appropriately position themselves to meet the stringent demands for high quality equipment and machinery as well as meet the requirements equipment maintenance for high performance of the energy sector. (Kenya Vision 2030; Uganda Vision 20140; and The Tanzania Development Vision 2025)

Equipment manufacturers often use the laser in production processes such as profile cutting and welding of metals; the laser is often utilized in profile cutting of sheet and plate metal whereby a large number of parts are nested to improve material usage and avoid wastage. The laser is also used for maintenance and repair works involving surface hardening and surface cladding of worn out machine components. The process benefits that will be realized from utilization of laser technology in East Africa's manufacturing industry include high productivity through high processing speeds, reproducibility of high product quality, and flexibility of manufacturing as the same laser source can be used for different production processes.

## **4.3 Agro Processing Sector**

A large proportion of East Africa's population is directly or indirectly engaged in agriculture as a source of their livelihood; therefore, the potential competitive advantage of the region lies in agro-industrial exports which require increased capacity for value addition in agro-based industries (Uganda Vision 2040). Therefore, there is need to attract strategic investors to boost agro-based industries in order to compete globally especially in new markets; the investments in agro-processing industry are expected to bring new skills and technologies for enhanced productivity and production of high quality products.

## **4.4 Transport Sector**

One of the cross-cutting strategies that are critical for achievement of superior performance of the various sectors of the economy is improving transport infrastructure, such as ports, rail and highways. Kenya and Uganda (EAC, 2016), are in the process of reviving the high standard railways

connecting the region for passenger and goods transportation across the region. Good examples are the Standard Gauge Railway and the Lamu Port and Lamu South Sudan Transport Corridor projects. This kind of projects involved heavy and expensive machinery that requires well-equipped installation for preventive maintenance and repair.

#### **4.5 Mining Industry**

The East African states are endowed with minerals - including gold, copper, iron ore, etc - that have not yet been optimally exploited for national gain. The mining sector is still undergoing development to improve efficiency and effectiveness of the mining operations (Uganda Vision 2040). The mining sector development requires improvement in the technologies and maintenance of the equipment used in the mining activities. Laser materials processes such as laser cladding and laser welding will be essential in ensuring efficient maintenance of mining equipment.

#### **5.0 Conclusion**

Despite the prospects for the manufacturing sector in the East African region, the sector is currently grappling with challenges in the areas of capital, skilled labour, and infrastructure. Additionally, the development of the manufacturing capacity of the East African region requires improvements in electricity access and improvements in transport infrastructure through both refurbishment and building new transport infrastructure. Therefore, the manufacturing sector will benefit from improved government policies promoting local manufacturing, private sector investment, infrastructure development, improved skills development training programmes and facilities, and better business environments. Introduction of laser technology as enabling technology would give a competitive edge to the nascent but dynamic automotive industry especially in truck and trailer construction, would facilitate installation, maintenance and repair of multi-billion oil, energy and rail infrastructure, would enhance the technology and knowhow transfer and local content of investment and would create highly-skilled jobs for the youth and definitely will foster a knowledge-based economy.

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