MTC

- Independent RTO
- 900+ employees
- Training & Skills
- Engaged with Academia and Industry
- Develop and de-risk technologies
- support businesses with off-the shelf solutions

Prove Innovative Manufacturing Ideas & System Solutions

CATAPULT High Value Manufacturing

UKRI Innovate UK

mtc where progress happens

Lasers in Food

Introducing a new technology: Laser Cooking

Dr Mickey Crozier

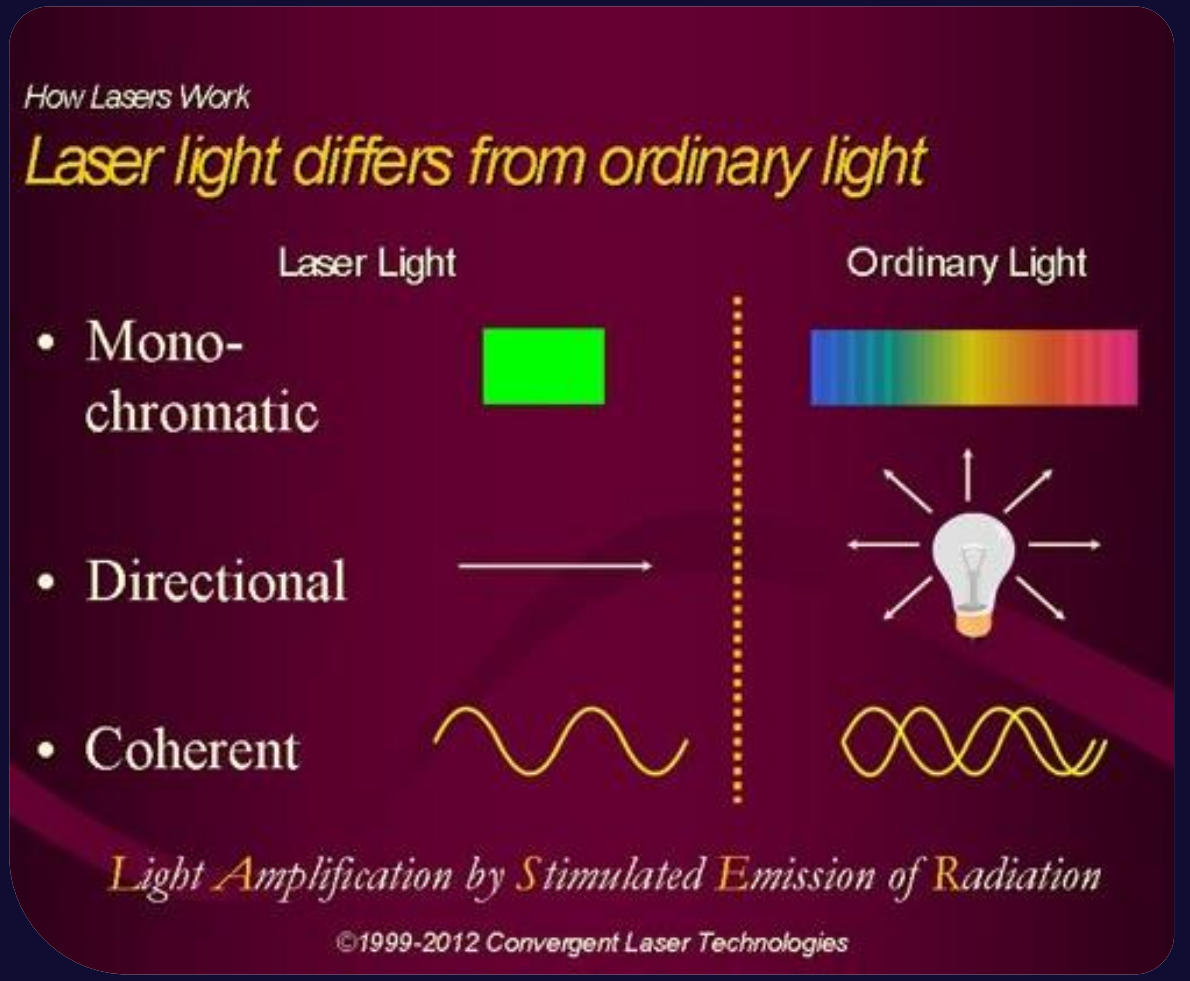
24/07/2024

mtc where progress happens

Introduction

Laser Basics

- Lasers are light sources with unique properties.
- Monochromatic i.e. they are made up of a single ‘colour’ or wavelength
- Highly directional, minimal divergence (spread).
  - A low power (<5mW) laser pointer can be visible >1km away.
  - More powerful lasers are used to accurately measure the distance of the moon.
- They are coherent both spatially and temporally
- These properties allow lasers to deliver a lot of energy in a small space, enough to vaporise, melt or mark many materials.



https://www.convergentlaser.com/laser-safety (accessed 2024)

Laser Applications in Food and Drink

The use of lasers in the food and drink industry is growing.

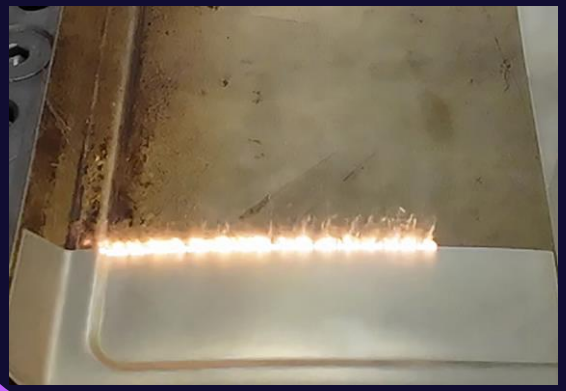
There are established markets for marking of packaging.

Newer applications including direct product marking, cleaning and even direct laser cooking are beginning to emerge.

Marking

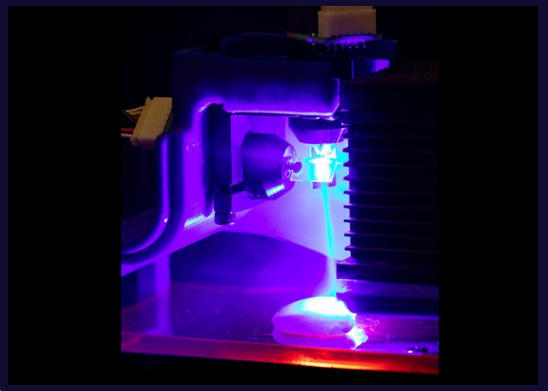
Product Marking & Traceability Solutions | Videojet UK

Cleaning



Lasers Clean Fast, Precisely and Sustainably Without Detergents or Abrasives | Food Engineering (foodengineeringmag.com)

Cooking



Now We're Cooking with Lasers | Columbia Engineering

Typical Benefits of Lasers

- **Non-contact.** No cross contamination, no tool wear and reduced cleaning operations.
- **Environmentally friendly.** Reduce labelling, clean without chemicals, low energy usage.
- **Digitally controlled.** Easy to switch between products and mark dynamic data like barcodes/serial numbers/QR codes.

Laser Marking

Packaging

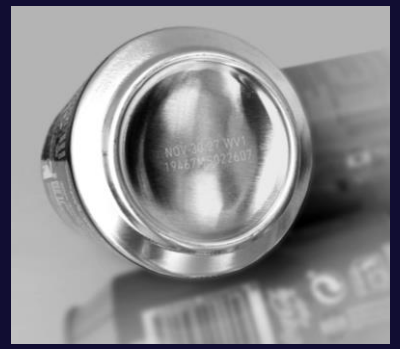
Laser produces a mark directly onto packaging.

Contrast of the mark can come from:

- **Coating removal**
- **Chemical change at the surface**
- **Material removal (embossing)**

The ideal laser for the job depends on the properties of the material to be marked.

MTC can help you develop the process and equipment.



The Laser Marking for Food Packaging (dplaser.com)
Food & Beverage Packaging | Environmentally Friendly (luxinar.com)
Laser marking drink cans | Macsa ID

Laser Marking

Direct Product Marking

Direct marking of food products is beginning to be trialled by some retailers.

With the right laser process shelf life and eating quality are unaffected.

Remove the need for sticky labels and the associated costs and carbon footprint.

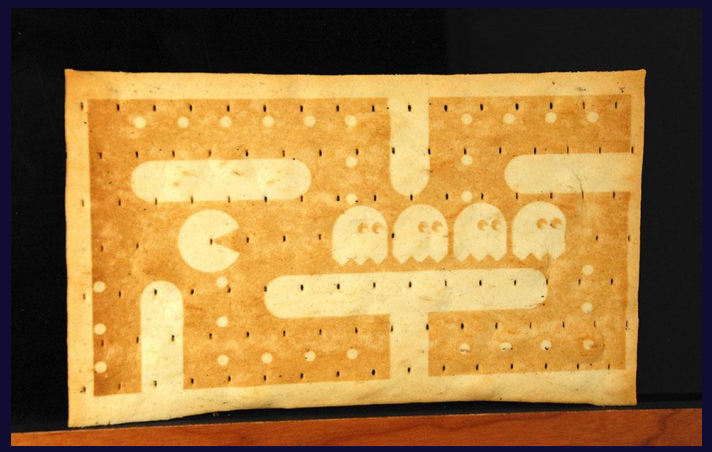
Laser-etched labels trialled on Tesco avocado range (foodmanufacture.co.uk)
Swedish supermarkets replace sticky labels with laser marking | Guardian sustainable business | The Guardian

Laser Marking

Personalisation

Lasers can also be used to add personalisation or branding directly to a product.

This is currently quite a niche application but could be used more widely for branding or applying ‘cosmetic’ marks like grill lines on meat products.



Why we recommend laser marking on food? — Monportlaser
Food Laser Applications for Laser Engravers and Cutters (epiloglaser.com)

Lasers in Food Production

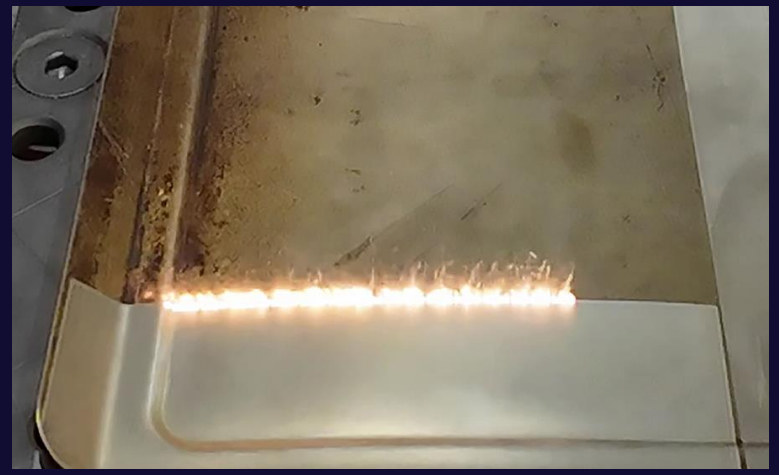
Laser Cleaning

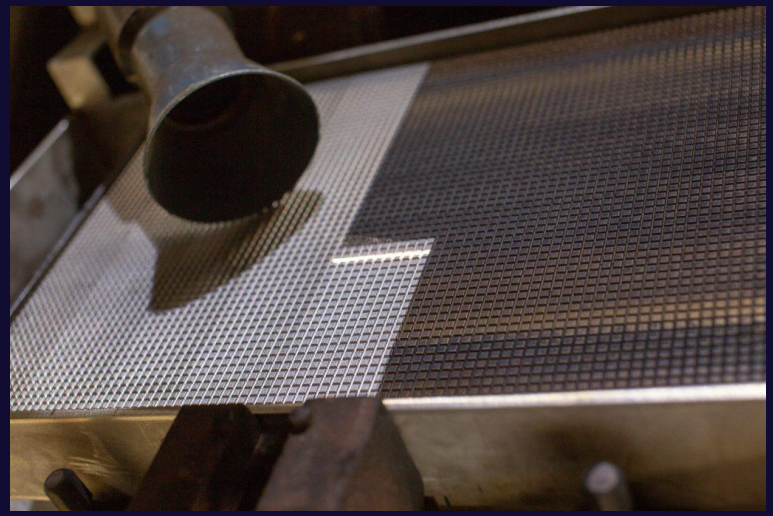
Lasers are excellent for cleaning organic contaminants from metal surfaces.

With the right process all dirt is removed without damage or wear to the underlying surface.

Laser cleaning is fast and uses no water or chemical cleaners.

Both automated systems and hand held laser cleaners are available.





Lasers Clean Fast, Precisely and Sustainably Without Detergents or Abrasives | Food Engineering (foodengineeringmag.com)
Food industry – Baltic-P-Laser

Lasers in Food Production

Handheld Laser Cleaning

There are established handheld laser cleaners on the market.

MTC can offer training and advice on safe implementation of handheld laser cleaning.

MTC are developing their own small, light and low cost handheld laser cleaning system.

We are looking for partners for application testing.

MTC are working on a very low cost, small, light and safe handheld laser cleaner.

Lasers in Food Manufacture

Laser Surface Texturing

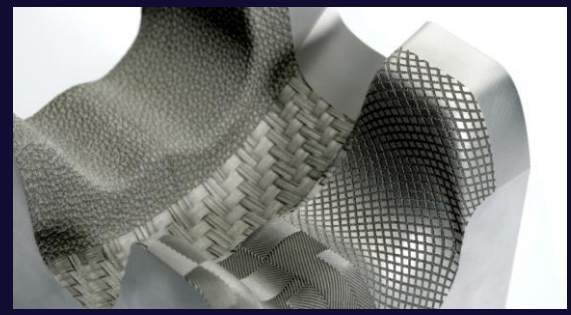
Lasers can machine very small features into surfaces, much smaller than the width of a human hair.

Changing the geometry of a surface at those length scales can alter water or fat contact angle.

This can impart functional properties:

- **Self-cleaning**
- **Anti-stick**
- **Improved thermal conductivity**

MTC have demonstrated laser surface texturing with Unilever in Horizon2020 project SHARK.



Functionality	Performance
Ice cream plate (anti-icing)	35% reduction in adhesion (under controlled environment) No significant change in adhesion (under actual machine environment)
Ice cream mould (anti-icing)	<5% reduction in adhesion
Ice-cream mould (Higher thermal conductivity)	~20% reduction in cooling time

Direct Laser Cooking

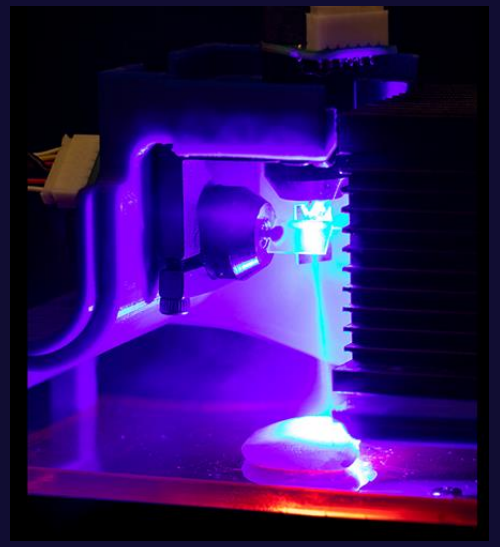
Direct Laser Cooking

Use of lasers for direct cooking of food products is an emerging application area.

IPG are leading the way and have a laser tailored specifically to cooking.

Potential benefits:

- **Lower energy utilisation**
- **Faster cooking times**
- **Less shrinkage and water loss**
- **Highly automated and low maintenance/downtime**
- **Controllable and repeatable process.**



Now We're Cooking with Lasers | Columbia Engineering

Laser cooked cookies, courtesy of IPG
Laser Cooking (foodengineeringmag.com)

Summary

- Lasers have many potential uses in food manufacturing from marking of packaging (established) all the way through to direct laser cooking (emerging).
- Lasers have benefits in terms of sustainability, repeatability and cleanliness.
- Total cost of ownership of laser equipment is typically lower than other traditional equipment due to low running costs but the initial capital investment is higher.
- MTC can help you develop, prove and demonstrate laser process and work with you to develop the business case for laser equipment.
- We also offer training for your existing staff to support introduction of laser technology into your facility.

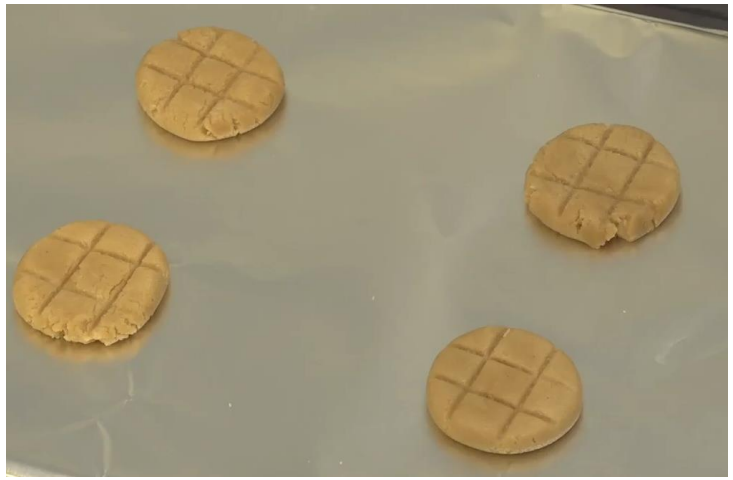
Laser Solutions for the Food & Beverage Industry

July 2024

Lasers I Solutions for the Food and Beverage Industry

Fast, Sustainable and Precise

Baking



Fast
- Peanut butter cookies in 90 sec

Efficient
- Heats the product, not the Factory

Sustainable
- Low energy consumption
- No consumables or maintenance

Drying

Fast
- Dry apple slice in 10 min

Efficient
- “Cold Oven”, little waste heat

Precise
- Infrared metrology for temperature control

Cleaning

Fast
- 1,200 m^2/hr demonstrated

Effective
- Sterile, low contact angle

Sustainable
- No byproducts, low energy consumption

IPG Photonics At-a-Glance

1990
FOUNDED

~6,200
EMPLOYEES

20+
COUNTRIES

$1.4B
REVENUE

~100,000
LASERS SHIPPED

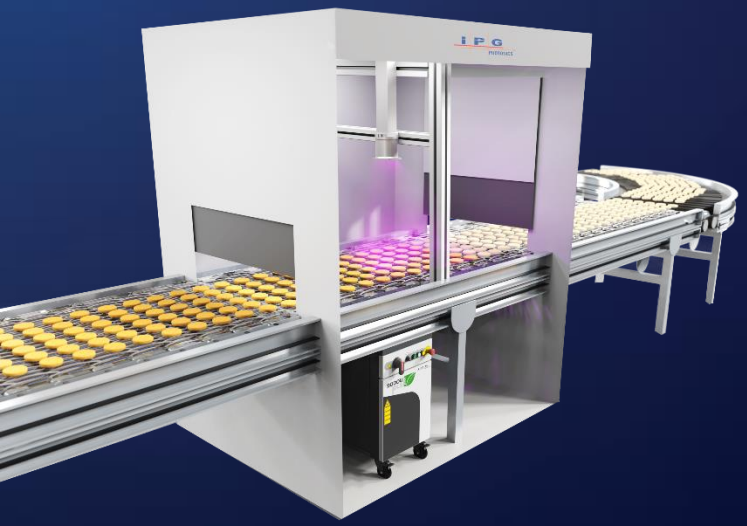
~9,000
TURNKEY LASER SYSTEMS SHIPPED

5,000+
CUSTOMERS ACROSS 6 MAIN INDUSTRIES
Based on 2023 Data

Nasdaq
IPGP
2004 IPO
Massachusetts HQ

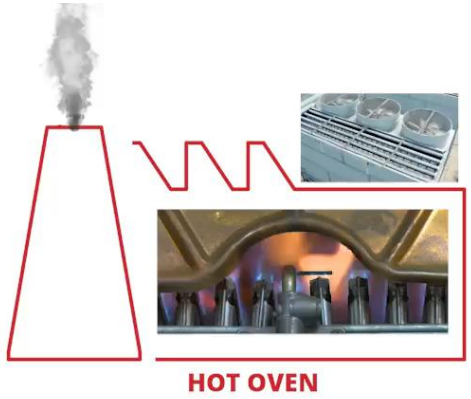
- World's largest volume supplier of Lasers to Industry
- Unique, vertically integrated Supply Chain
- Industry-leading earnings and cash flow

Laser Heater



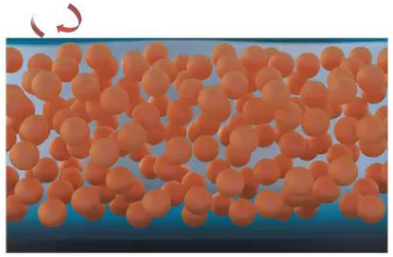
Laser Heater I Rethinking the Future

Lasers overtaking conventional ovens across many industries



HOT OVEN

HOT AIR
only dries the surface
which reduces throughput
and wastes energy



Sub-surface moisture requires time to be
drawn to the surface before it can be removed

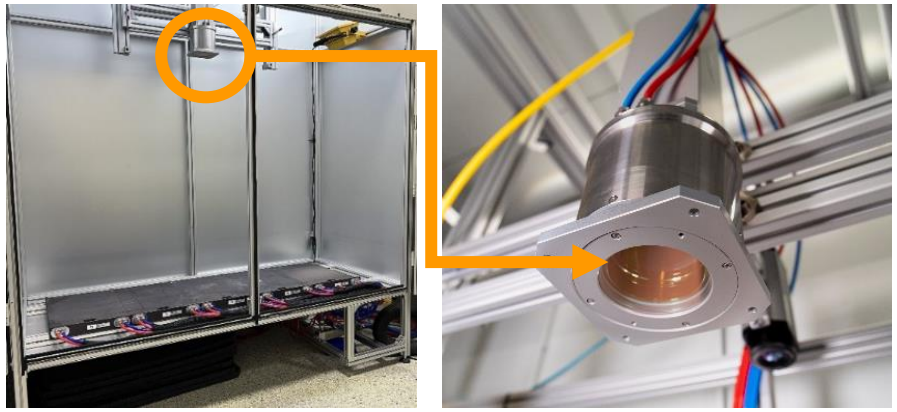
Food & Beverage Applications

- Pre-Heating
- Baking
- Drying

Industries engaging IPG

- Li-ion Battery
- Industrial Coatings
- Food & Beverage
- Chemical & Pharma
- Ceramics
- Silicon chipmaking
- Pulp & Paper

Laser Heater I a “cold” Oven



“**Cold**” Oven
Paradigm Shift

An Oven which isn’t Hot

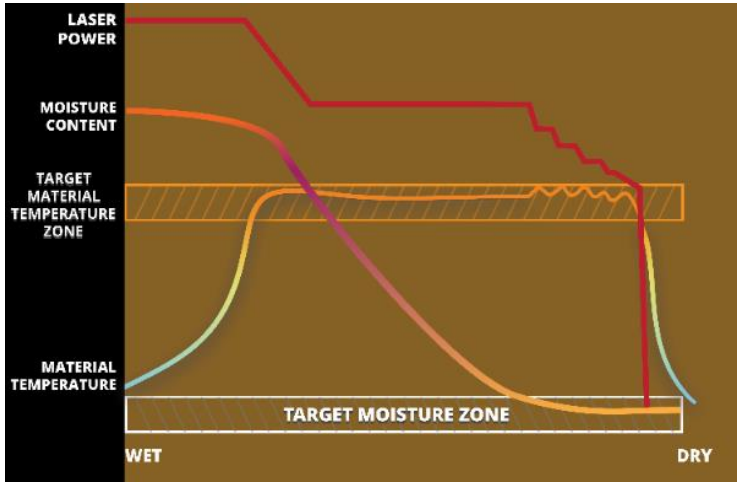
- Heats only targeted material
- No thick, insulating oven walls
- Little heat radiates into the factory

Consumes energy only when on

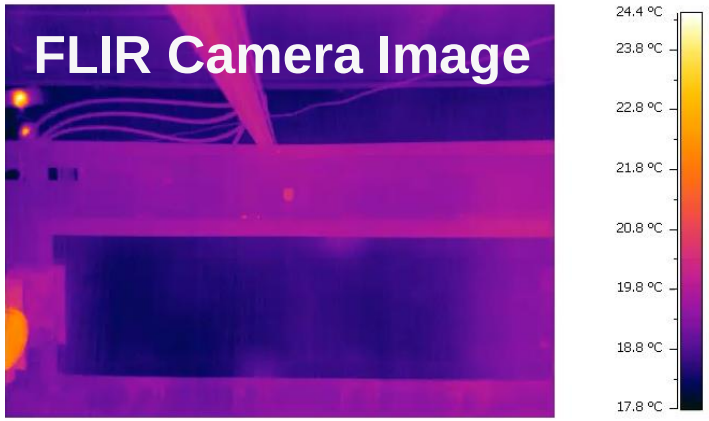
- Agile: on/off in milliseconds
- No warm-up, no idling

Infrared Metrology

- Process control



Drying Process Control
Speedy pre-heat
Speedy drying in Bulk
Endpoint Detection

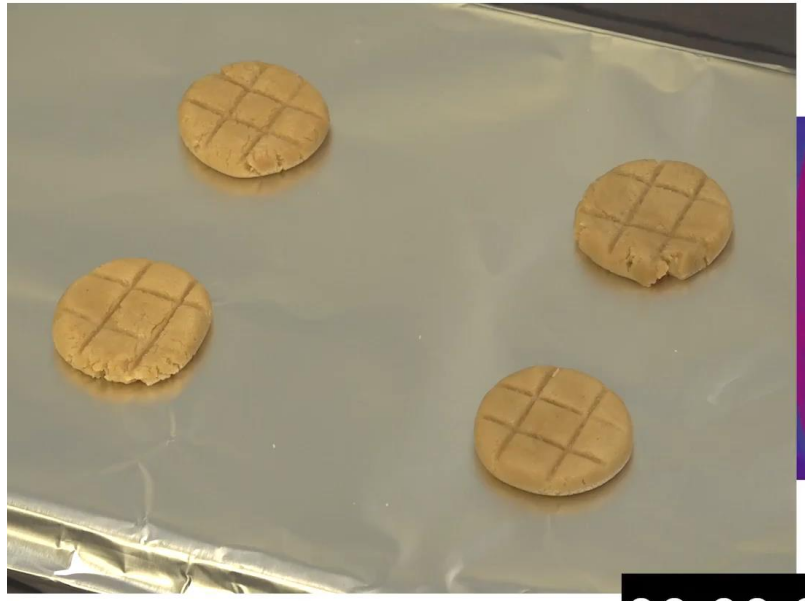


Baking I Peanut Butter Cookie Example

Peanut Butter Cookies

- Supermarket cookie dough
- Delicious after 90 sec at 290ºF

Manufacturer's Recommendation
- Preheat oven to 350ºF
- Bake 10-12 minutes



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Drying I Apple Slice Example

Apple Slices

- Sliced around 1mm thickness
- Delicious after 10 min at 60ºC
- Process would improve if laser illuminates fruit from both sides, convective air flow is optimized and if more reflectors are introduced to recycle reflected energy

DLS ECO

Apple Drying

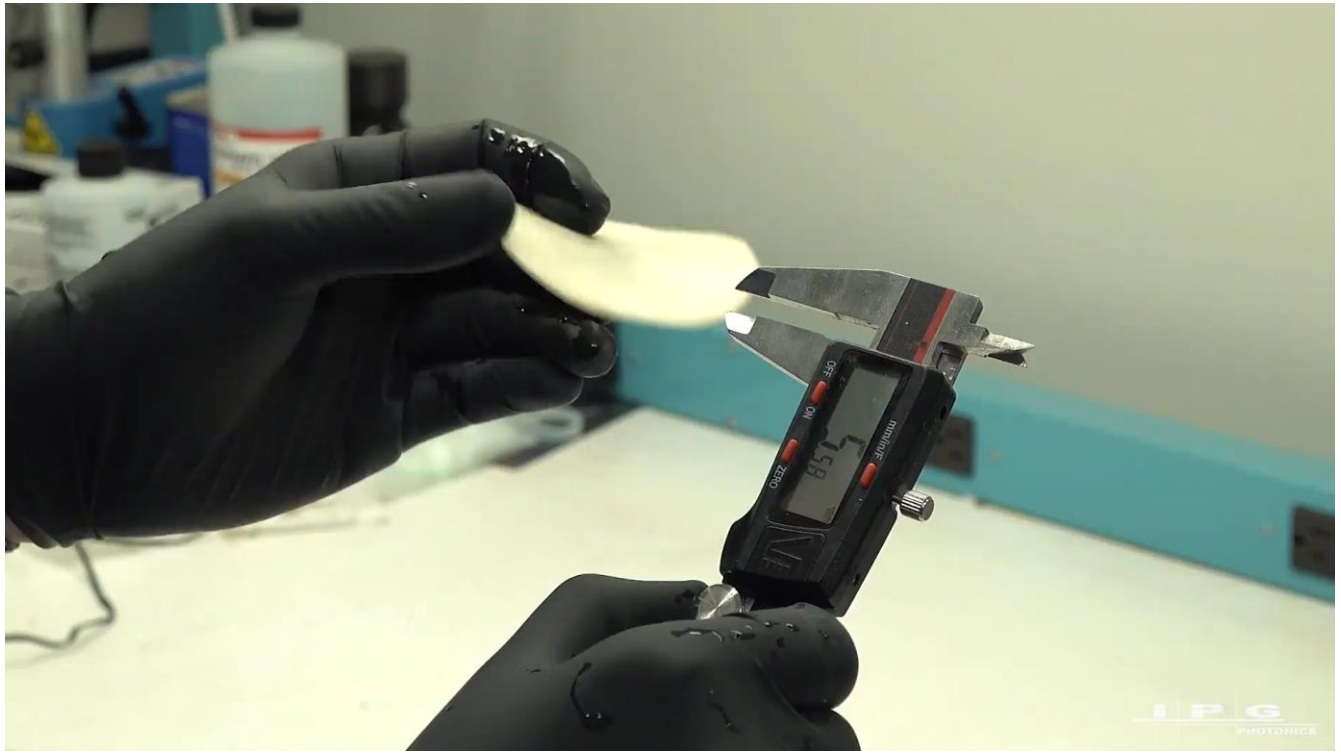
IPG PHOTONICS

IPG PHOTONICS

Drying I Potato Chip Example

Potato Slices

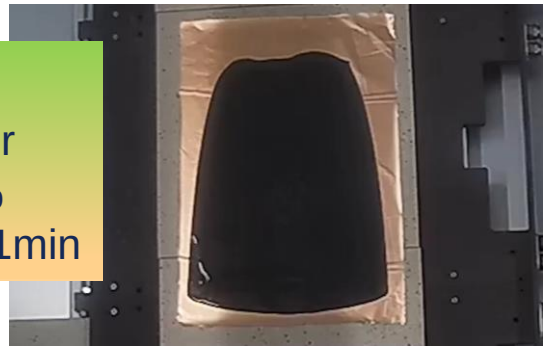
- Sliced around 2.4mm thickness
- Crispy after 7 min at 95ºC
- Process would improve if laser illuminates chip from both sides, thinner slicing, convective air flow is optimized and if reflective surfaces recycle reflected energy



Laser Heating I Operating Advantages

Benchmarking Analysis shared by Li-ion Battery Industry

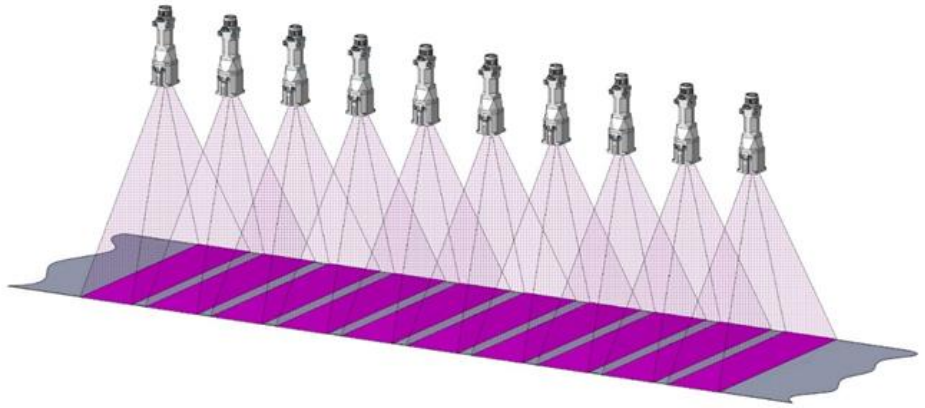
Electrode Drying: Laser removes 99% moisture in <1min



Energy Consumption - 500 kW Drying Oven

Replacement, Li-ion Battery, 90% utilization, US energy price

500kW Dryer Optical Efficiency	IPG Laser 55%	IR Lamp 32%
Annual Energy Consumption (8000hrs/year)	7.3 MW·hrs	12.5 MW·hrs
Annual Energy Cost ($0.11/kW·hr)	$800,000	$1,375,000
Annual Savings at US Energy Rates	$575,000	



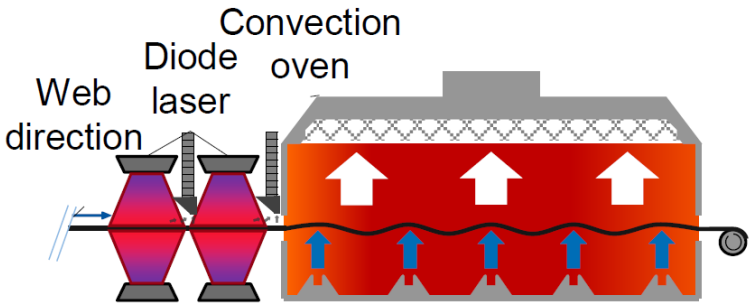
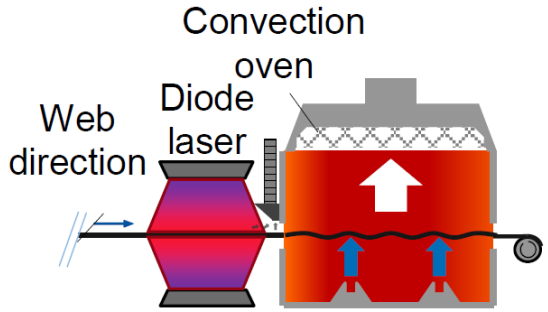
OpEx – Maintenance & Cooling

	IPG Laser 55%	IR Lamp 32%
Maintenance	Zero planned maintenance - 7 years	Replace Lamps every 1-2 years
Thermal Management	House Water	Exhausts heat into Factory

IPG's DLS-ECO laser heater is maintenance free, easy to cool, requires less factory floor space

Hybrid Ovens I Retrofit / Upgrade Strategies

Enabling Laser pre-heat for Convective Baking

Use-Case	Throughput Increase	Footprint Reduction
Concept		

Retrofit – Laser pre-dried/heated product travels faster through existing long oven

Green Field – Laser pre-heat enables shorter oven

Hybrid Ovens capitalize on the speed and efficiency of laser heating, while preserving the baking attributes of traditional ovens

DLS-ECO I Turnkey Lab System

A Portable and Safe Laser Laboratory

- Class I laser safety certified – safe to operate anywhere
- Integrates 2kW to 20kW DLS-ECO laser source
- Dual monitors for infrared metrology and viewing
- Thermal control loop tightly regulates sample temperature
- Write, save, repeat and edit job files
- Fume exhaust management, thermal cold-plate
- IPG chiller

Laser Heater I Key Take-Aways

Process Optimization

High Speed

Process Monitor

Cost-of-Ownership Advantage

Energy savings

7+ Years Maintenance-free

Factory Improvements

Footprint Slashed

Zero Thermal Load

Precise Infrared Metrology

Fast Heating, High Laser Efficiency lower Energy Consumption

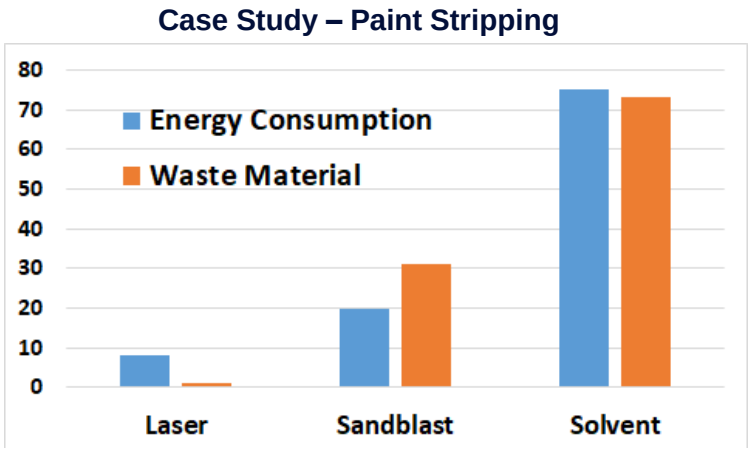
“cold” Oven slashes Factory Floorspace Requirements

Laser Cleaning

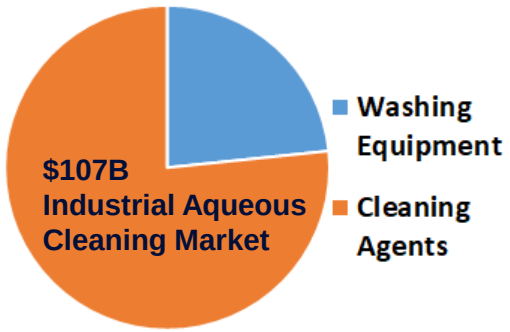
Laser Cleaning I Value Proposition

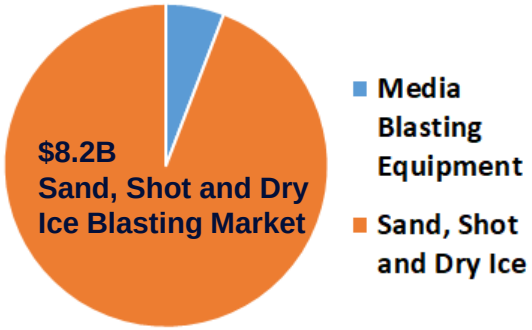
Consumables Free, Productive and Sustainable

Laser Slashes Energy Consumption and Waste



Aqueous & Abrasive Cleaning Spend Dominated by Consumables



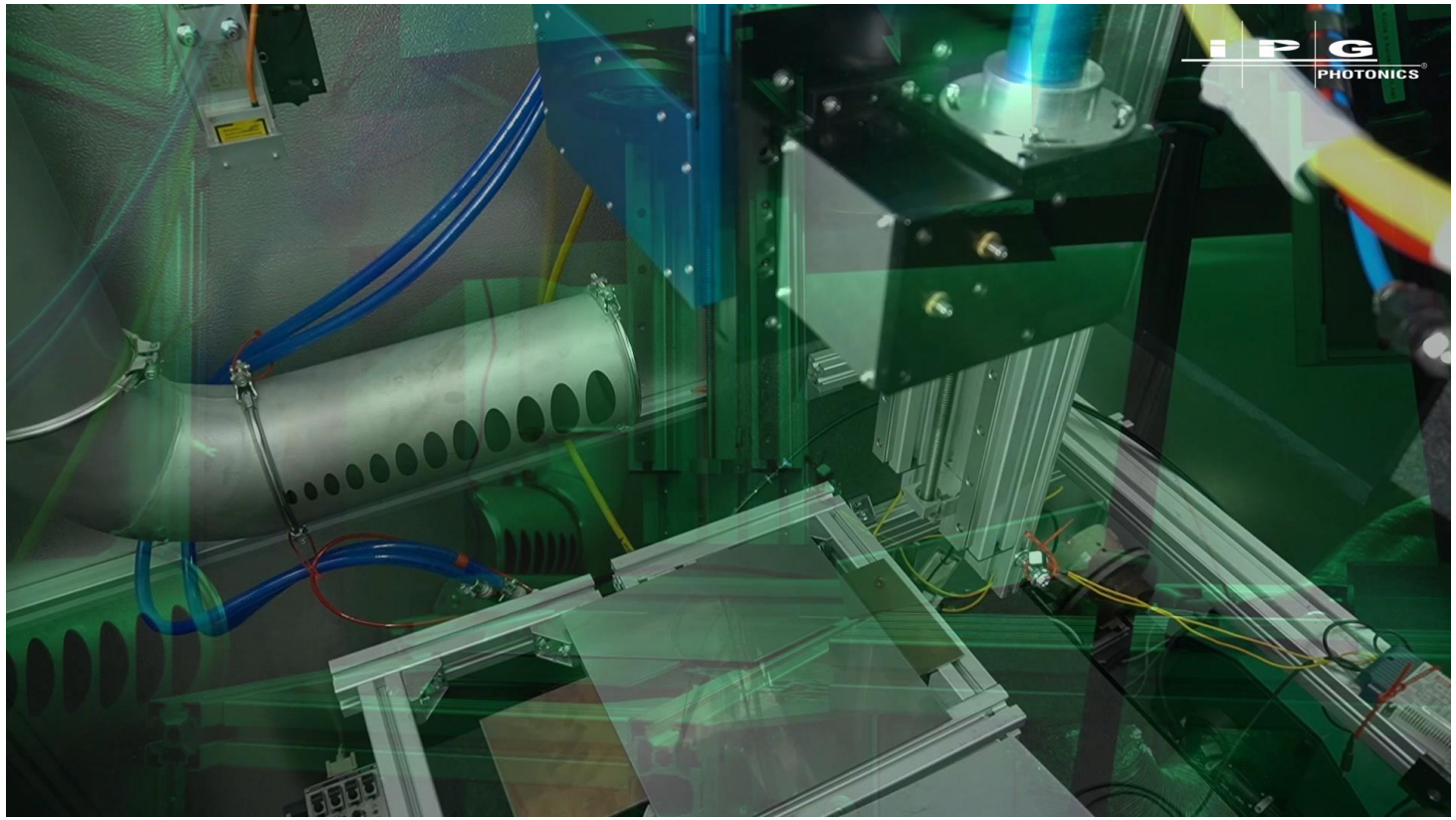


Laser Cleaning Attributes

Productive	Cleans quickly
Sustainable	Consumable-free, saves energy
Selective	Cleans only where needed
Low OpEx	Maintenance-free, eliminates consumables
Safe	Easy-to-operate, non-toxic, quiet
Touchless	Damage-free surface, extends part lifetime

Laser Cleaning I Speed Record

200 milliseconds to degrease an 8.5”x11’ metal surface



Laser Cleaning with Fast Scanner

- >1,000 m^2/hour degreasing/drying
- Laser spot translates >1 km/sec
- Waste material conveniently sequestered
- Consumables-free

Laser Cleaning I Bakeware Example

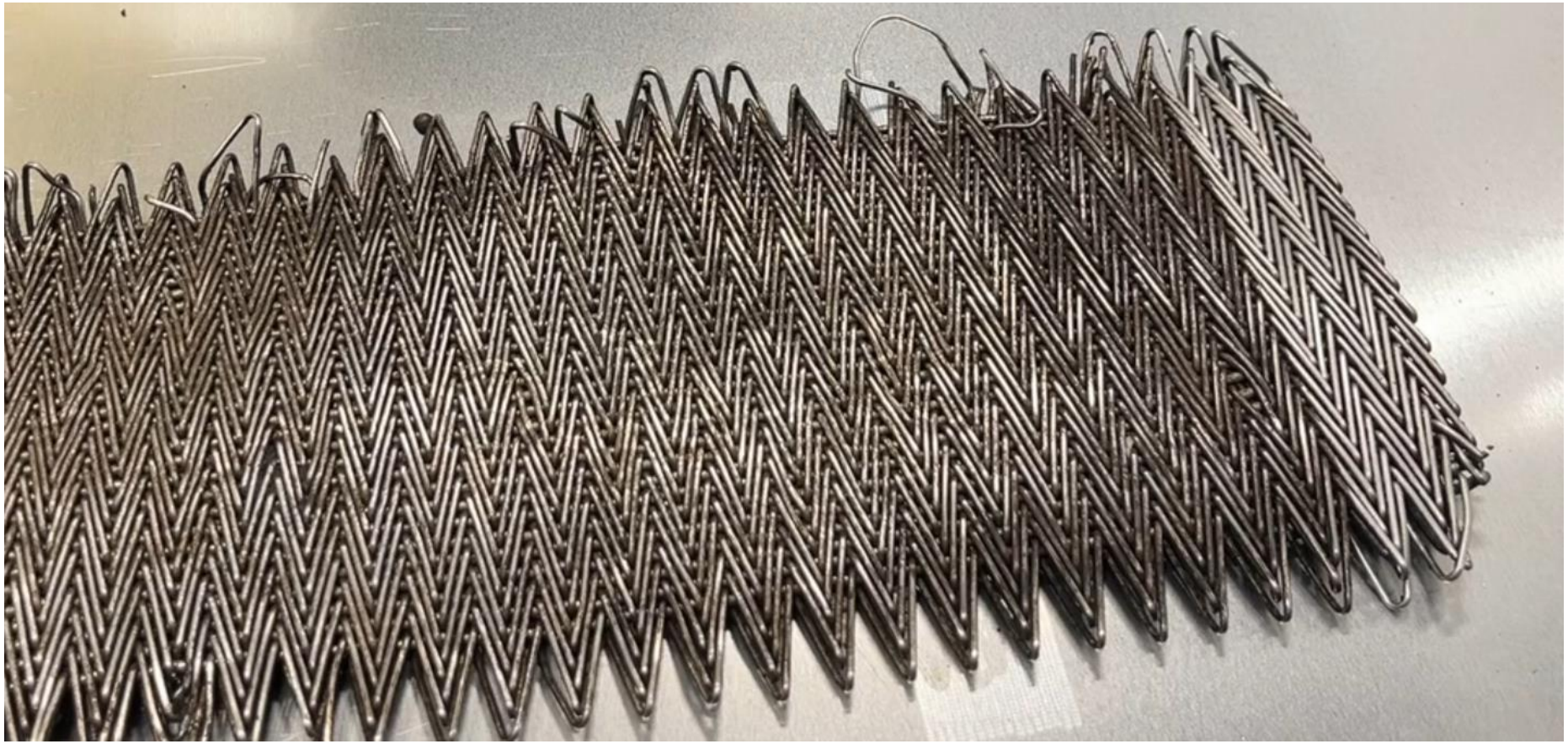
Fast, no Byproducts, Touch-Free, Selective and Safe

Clean enough to eat off…

- Laser sterilizes the surface it cleans

Laser Cleaning I Conveyor Belt

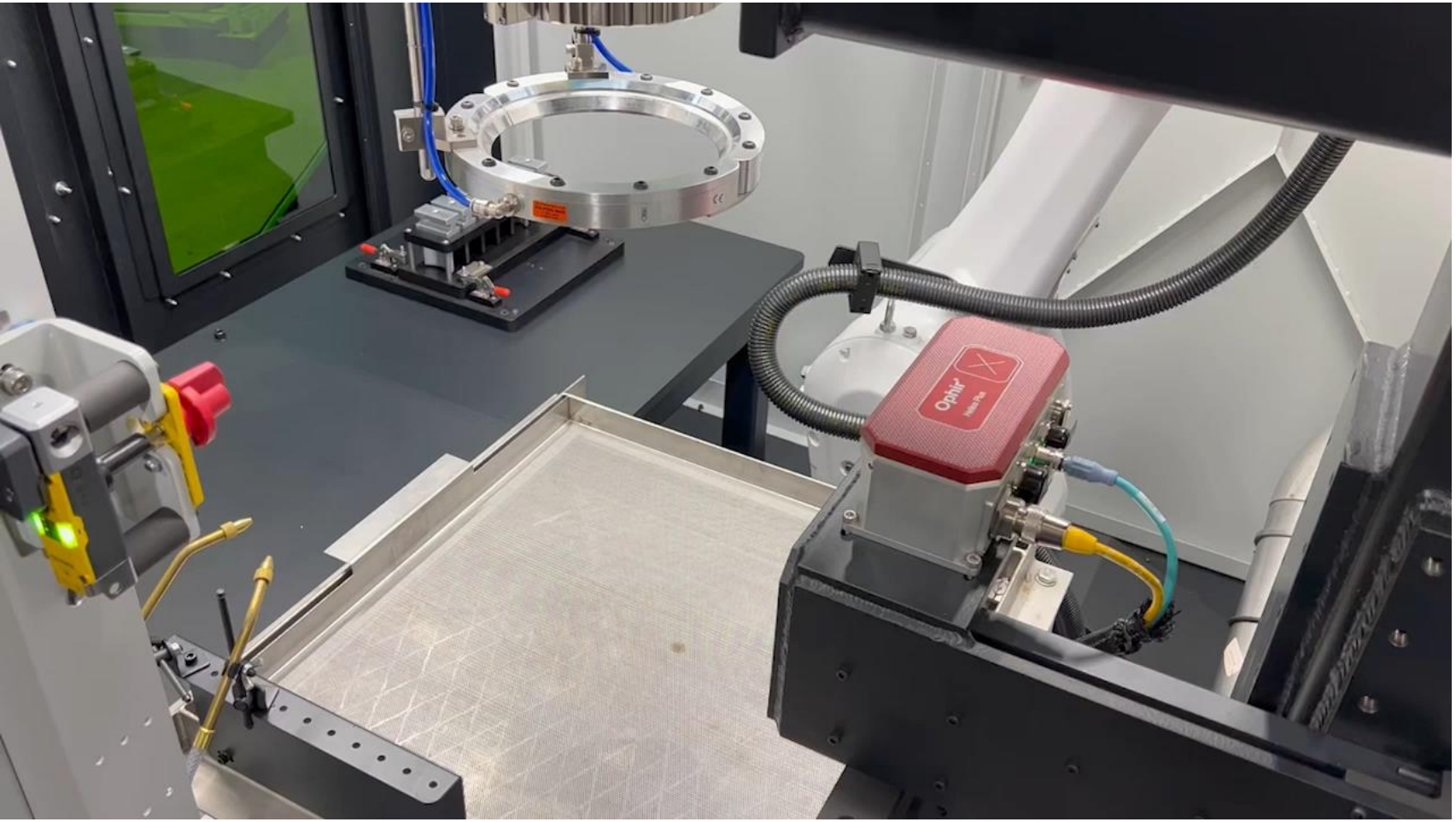
Fast, Sterile, no Byproducts, Touch-Free, Selective and Safe



Possibility to clean belts in-situ

Laser Cleaning I Suited for Automation

Fast, Sterile, no Byproducts, Touch-Free, Selective and Safe



Aerospace Turbine Example

- Robotic Cleaning Cell
- High Value parts refurbished
- Touch-free, laser cleaning is efficient, extends part life
- No by products, ablated coating is sequestered by fume management system

Laser Cleaning I Key Take-Aways

Process Optimization

High Speed

Selective

Cost-of-Ownership Advantage

Low Maintenance

Non-contact – Parts last longer

Factory Improvements

Eliminates Toxic Chemical and Grit Blast Waste

Low Energy Consumption

Precise, Sterile and Reproduceable

Productive and Extends Part Life

Sustainable – no consumables or by product

Laser Solutions for the Food & Beverage Industry

July 2024