

APPLICATION OF LASERS IN AUTOMOTIVE INDUSTRY

PRIMENA LASERA U AUTOMOBILSKOJ INDUSTRIJI

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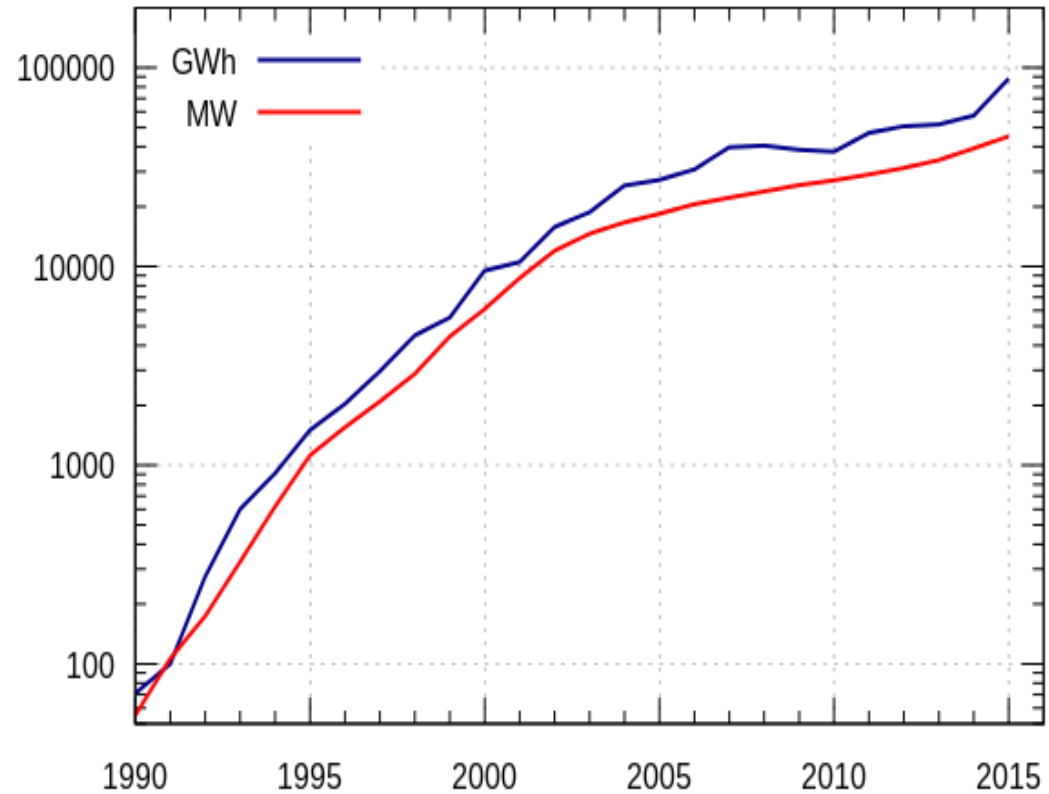
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Sun and wind

- Almost all renewable energy and also fossil fuel energy originate from the Sun's energy.
- For a long time, Germany was leading in wind power production capacity. In 2008 Germany had dropped to the second place and in 2010 to third, with the China taking advance.



Wind power in Germany 1990-2015



Technology and metrology in applications

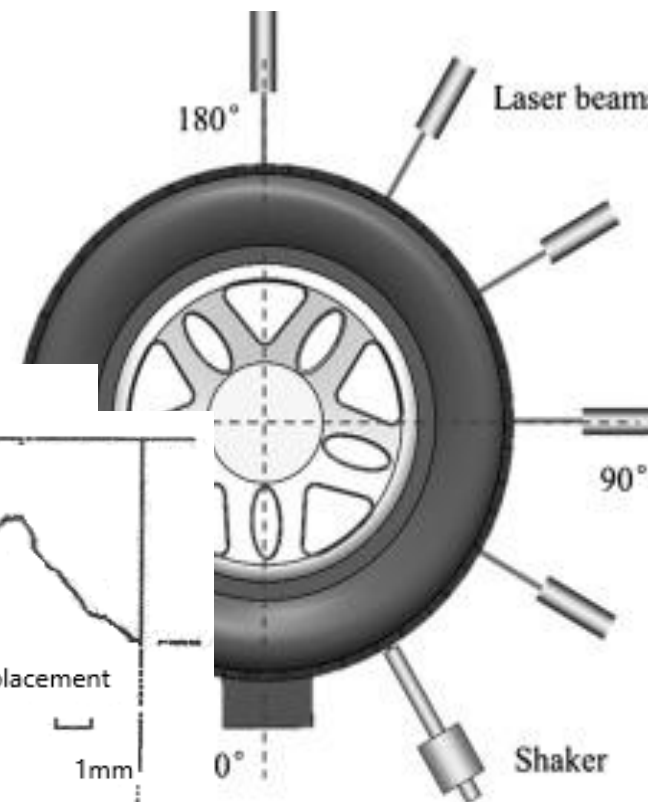
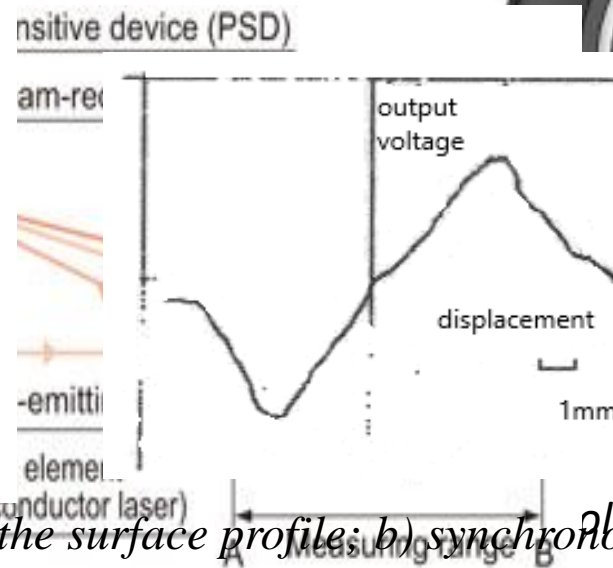
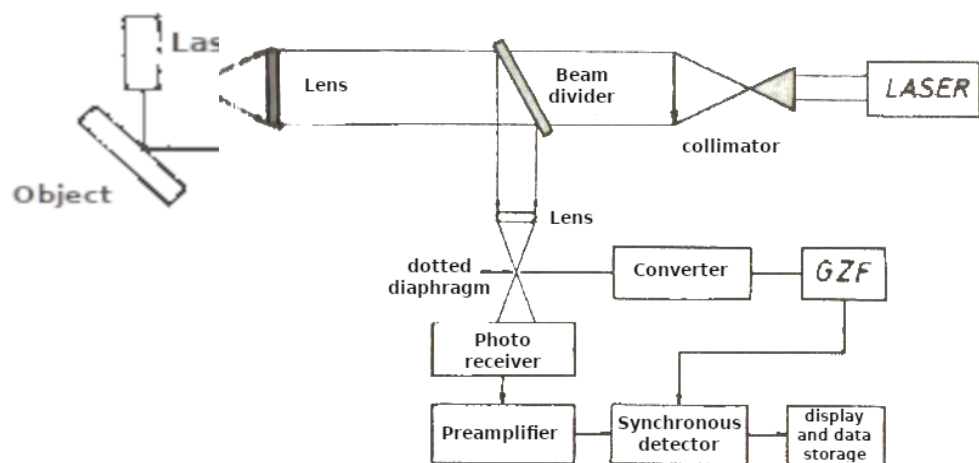
- The use of lasers in automotive/vehicle industry, aircrafts and shipbuilding maritime industry for civil and military purposes, rises.
- The application of lasers in the measurement technique of vehicle production and control are among the measurements developed on the basis of coherent sources for non-destructive testing (NDT) of: fatigue, vibration, deformation, flow and combustion processes.
- To control oil purity and combustion processes, a number of spectroscopic methods are used

Technology and metrology in applications

- In *pure* processing of materials in automotive industry, laser role is included through the tasks in engraving, printing on metal parts, drilling, cutting, welding (processing of objects of various geometry), printing through glass or other materials layers, after the system has been assembled.
- Profile and surface quality examination, and the surface position measurement are also performed by laser (tires).
- For true reproduction of the 3D representation, the method of profilometry of the template is used.

Control / measurement

- Examples of control and measurements



Displacement measurement a) Block diagram for measuring the surface profile; b) synchronous detector output of a tire with a laser beam
 Laser displacement measurement



Optical vibration measurement

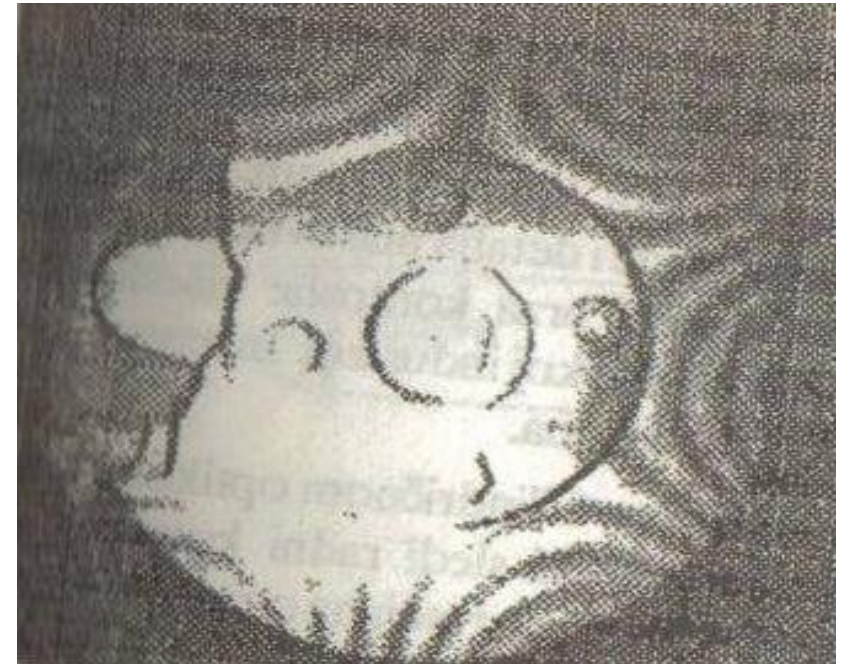
- General methods of vibration measurement

| | Real time holography | Pulse holography | SOVAS |
|---------------------|------------------------------|--|---|
| Object | Single construction elements | Construction blocks, aggregates, chassis | Construction blocks, aggregates, movable parts of chassis |
| Measuring quantity | amplitude | Analysis regarding laser pulse | Speed |
| Measuring interval | 0.2-0.5 μm | 0.2-200 μm (extrapolated) | 0.001-1 m/s |
| Excitation | harmonic | Harmonic or auto-excitation | Harmonic or auto-excitation and excitation of noises |
| State of vibrations | Frequency variation | Dominant frequency time filtering | Spectral analysis |
| Mode of operation | forced | Transitional regime | Stationary regime |
| Time of measurement | surface | surface | 30x30 dots |
| Time of measurement | Several seconds | instantly | 10-300 s |



Active holography

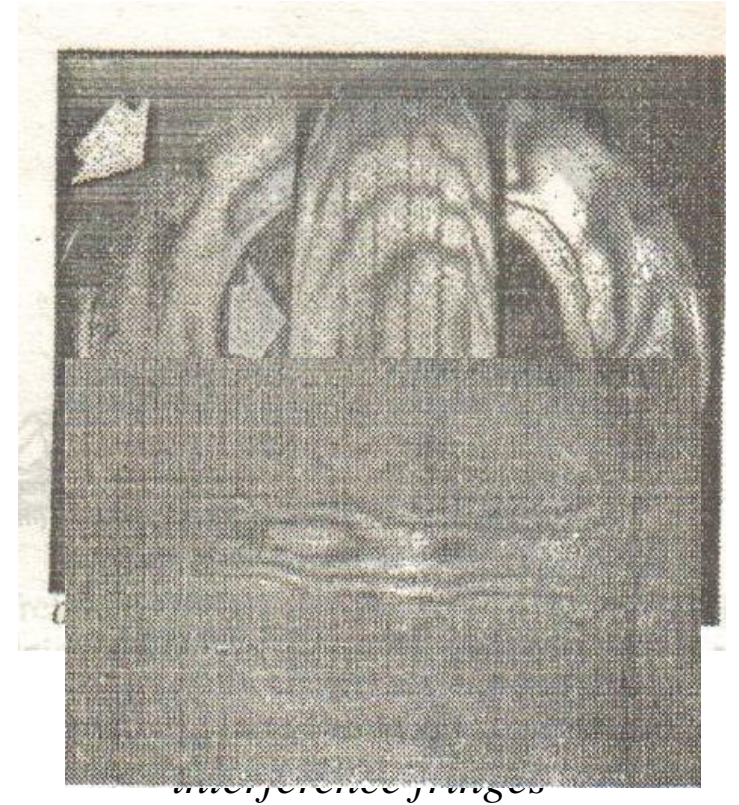
- Another application with laser technique is related to the technique of optimization of brakes from the stress-strain point of view
- The problems of real-time holography are related to: a) placing the hologram in the exposure position, b) distorting the photoemulsions and c) a detailed interpretation of the interference image in relation to the theory of local zones.



Vibration: technical optimization by holographic interferometry

Two pulse holography

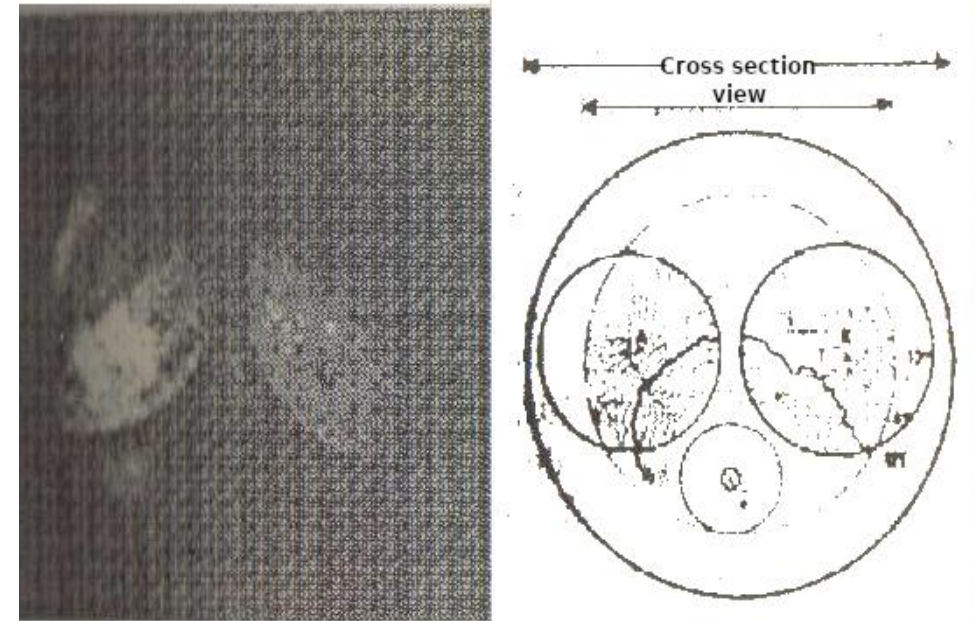
- Illumination with two pulses is used for the analysis of transient modes with a holocamera and adequate electronics, which evaluates the vibrations of the car body and the aggregates
- One of the first applications of holography in general, including this method, is based on the examination of pneumatics and defects in production and exploitation



Detail of hologram for defect analysis

Laser Doppler Methods: LDA and LDV

- If the Doppler effect is present in the methods, the methods inherit its name
- It is often used with the systems that follow both the development of techniques/technology and the widening of our experience from acoustics to area where relativistic effects had to be taken into account for the case of EM radiation.

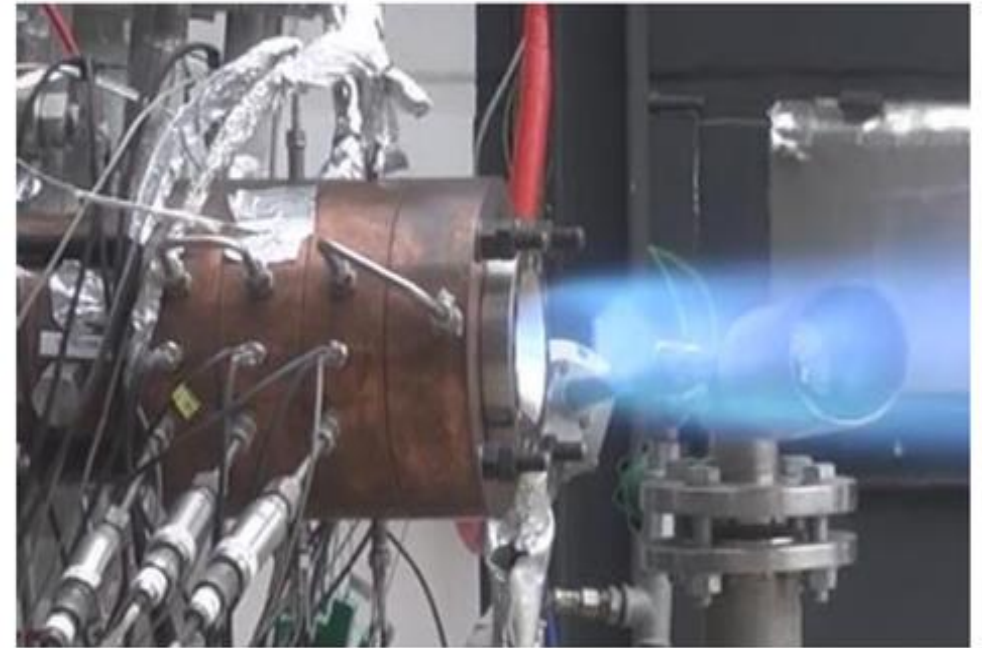


Schlieren method is used for motor dynamic control/monitoring

Laser Rocket Motors

- Laser rocket motors run on various energy sources (electrostatic, electromagnetic and electro-magneto-hydrodynamic and numerous others).
- They all have many advantages and disadvantages. Solar-powered laser rockets have the highest degrees of efficiency. Solar-powered laser rockets are the most efficient.
- One possible solution of laser implementation is where a directed, focused laser beam is absorbed in some solid, liquid or gas fuel.
- Optoelectronic systems are used for energy transport from Earth to orbital stations; the purpose of these systems is the transmission of CO₂ and free electron laser beams,

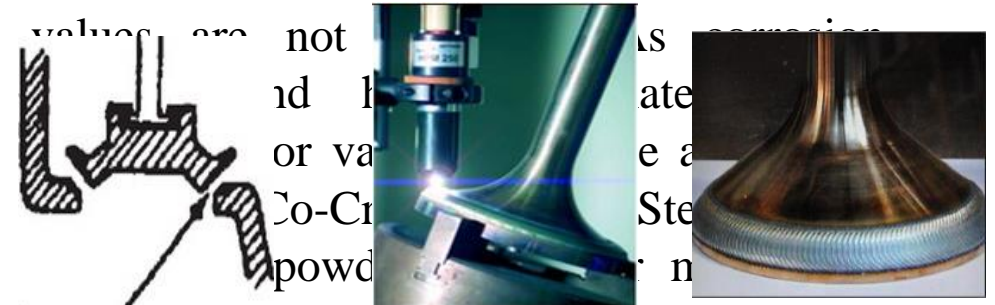
Laser-ignited combustion



Plasma and Laser Cladding on Stainless Steel for Exhaust Motor Valves

- The exhaust motor valves are exposed to high temperature of hot combustion gasses, followed by the pressure at the contact surface with the valve seat.
- The valves for fossil fuel motors are manufactured from stainless steel materials, but many of which do not have satisfactory wear properties at high temperatures. The thermal stability can be improved by cladding.

Characteristics of cladding methods for engine valves. The contact surface between the elements (per unit) is sealed by a thin layer of Ni-Cr-Co alloy. After quenching from 1180°C in combustion gases, the material is treated; it means that hardness values are not as high as those of the base metal.

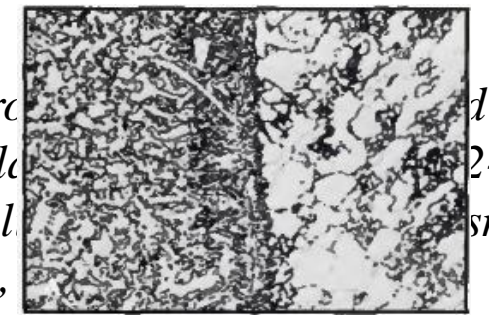
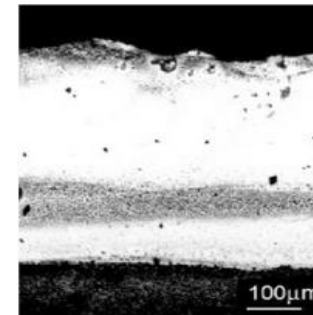
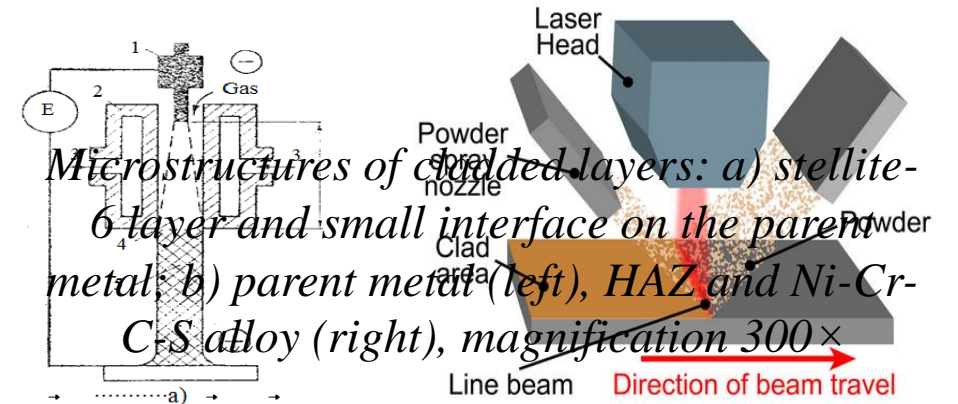


those alloys, the high energy welding methods should be used.
a) Contact surfaces between valve and seat, b) surface during cladding, c) cladded surface at the edge of motor engine valve



Plasma and Laser Cladding on Stainless Steel for Exhaust Motor Valves

- The laser beam produces high temperatures in interaction, even more than plasma torch. Powder for laser cladding could be fed from one or both sides
- For laser cladding of Co alloys, when sufficient energy of the beam reaches levels of >18 J/pulse, CO_2 or pulsed Nd^{3+} :YAG lasers are used. Heat affected zone, HAZ, and especially interface layer are very small after laser cladding



through the cladding process, the cooling rate is very high, and the plasma, ...

a) b)

CONCLUSION

- Laser cladding, melting, Small dissipation in powder material
- The study of technical characteristics of laser systems and laser types, as well as the study of other optical components, mechanical systems and the specificity of the designed devices
- Laser methods are leaving the laboratories and are not present in the field.
- Laser measurements, laser based microanalysis of material, Technical verification purposes
- Needs vs currently available technology. Important point of views – gasodynamics, aerodynamics, thermodynamics, numerical models, ...

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