Use of Pulsed Nd:YAG-Lasers in the Medical Industry

-The pulsed Nd:YAG (1.06µm) :
Processing of biocompatible Material

-Cutting,drilling, welding for
Instruments and Implants

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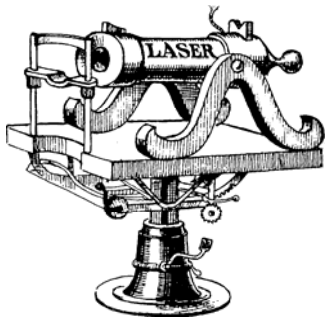
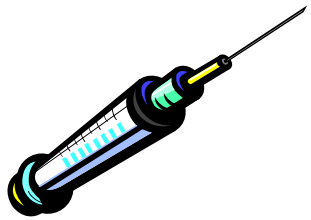
Laser in Medical Industry

- DIAGNOSTIC
- **Therapy**
  - Radiation Therapy
  - **Medical Technology**





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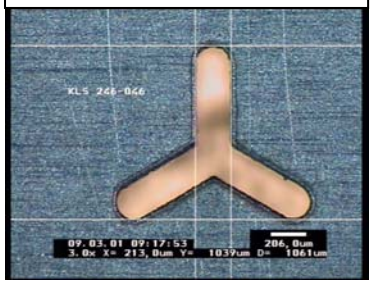
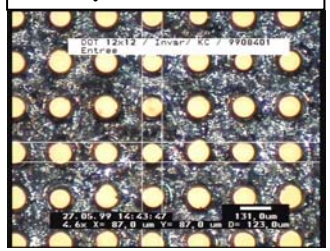
Laser in Medical Industry
(Material Processing)

- Production-Equipment
  - Casting Moulds
  - Spinnerets



- System-Components
  - Electronic
  - Dosing
  - µ-Filter



- Instruments
  - Needles
  - Cannule/Tube
  - Endoscope Catheder
  - Saws
  - Forceps etc
- Implants
  - Stent/Hypotube
  - Seeds
  - Pacemaker
  - Transponder

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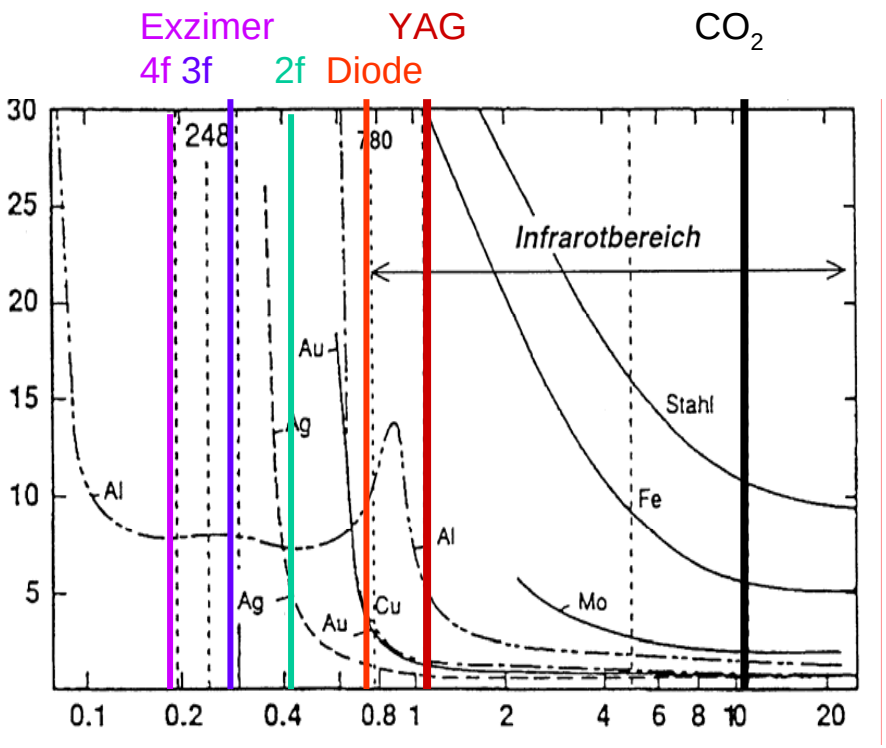
Which laser for which material (metal)?



Absorption (%) - Wavelength (µm)

	CO_2	Laser Jet	YAG µs/ns	Excimer
Ablation	-	-	0/+	+
Drilling	+	0	+/0	slow
Cutting	+	+	+/0	slow
Welding	+	-	+/-	-
Material				
Stainless Steel	+	+	+/0	0
Light Metalls(Ti)	0	+	+/0	0
Precious Metals	-	+	+/0	0
Hard Metall	-	+	+/0	0
Ceramics	+	+	+/0	0
Crystals	(+)	+	(+)/0	0
organic Material	0	0*	0"/0	0
Glasses	+	0*	0*/0	0
>2D-Contour	+	0	+/+	0
Precision:				
0.1mm	+	+	+	+
0.01mm	-	-	+	+
0.001mm	-	-	-	+Mask
Roughness(R_z) 0.05(mm)	+	+	+	+
Rauhigkeit(R_z) 0.005	-	+	+	+
0.0005	-	0	0	+
HAZ/deformation 0.1(mm)	+	+	+/+	-
WEZ/Verformung 0.01	-	+	+/+	+
0.001	-	+	0/+	+
Beam Delivery	Mirror	Mirror Fiber	Mirror Fiber	Mirror

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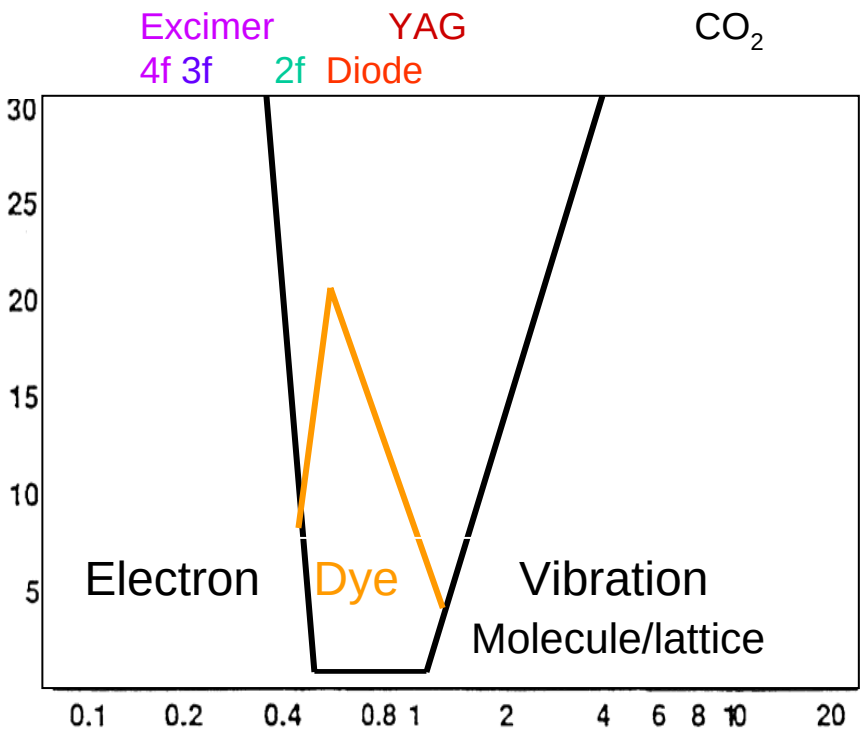
Which laser for which material (non metal)?



	CO_2	Laser Jet	YAG µs/ns	Excimer
Abtragen	-	-	0/+	+
Bohren	+	0	+/0	slow
Schneiden	+	+	+/0	slow
Schweissen	+	-	+/-	-
Material				
Stainless Steel	+	+	+/0	0
Light Metalls(Ti)	0	+	+/0	0
Precious Metals	-	+	+/0	0
Hard Metall	-	+	+/0	0
Ceramics	+	+	+/0	0
Crystals	(+)	+	(+)/0	0
organic Material	0	0*	0"/0	0
Glasses	+	0*	0*/0	0
>2D-Contour	+	0	+/+ 0	
Precision:				
0.1mm	+	+	+	+
0.01mm	-	-	+	+
0.001mm	-	-	-	+Mask
Roughness(R_z) 0.05(mm)	+	+	+	+
Rauhigkeit(R_z) 0.005	-	+	+	+
0.0005	-	0	0	+
HAZ/deformation 0.1(mm)	+	+	+/+	-
WEZ/Verformung 0.01	-	+	+/+	+
0.001	-	+	0/+	+
Strahlführung	Mirror	Mirror Fiber	Mirror Fiber	Mirror

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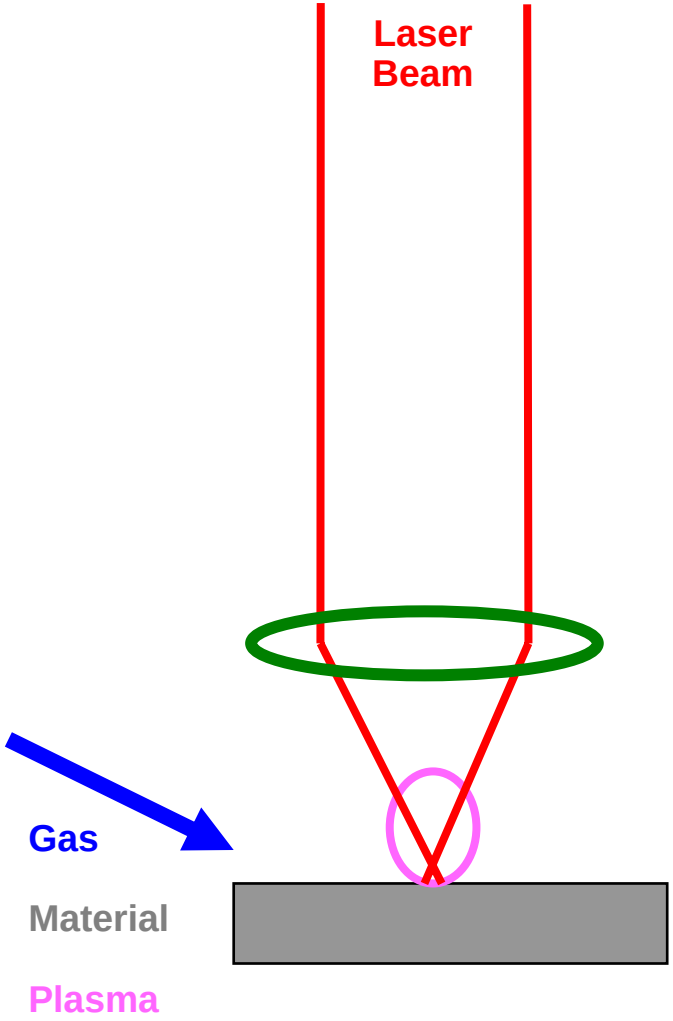
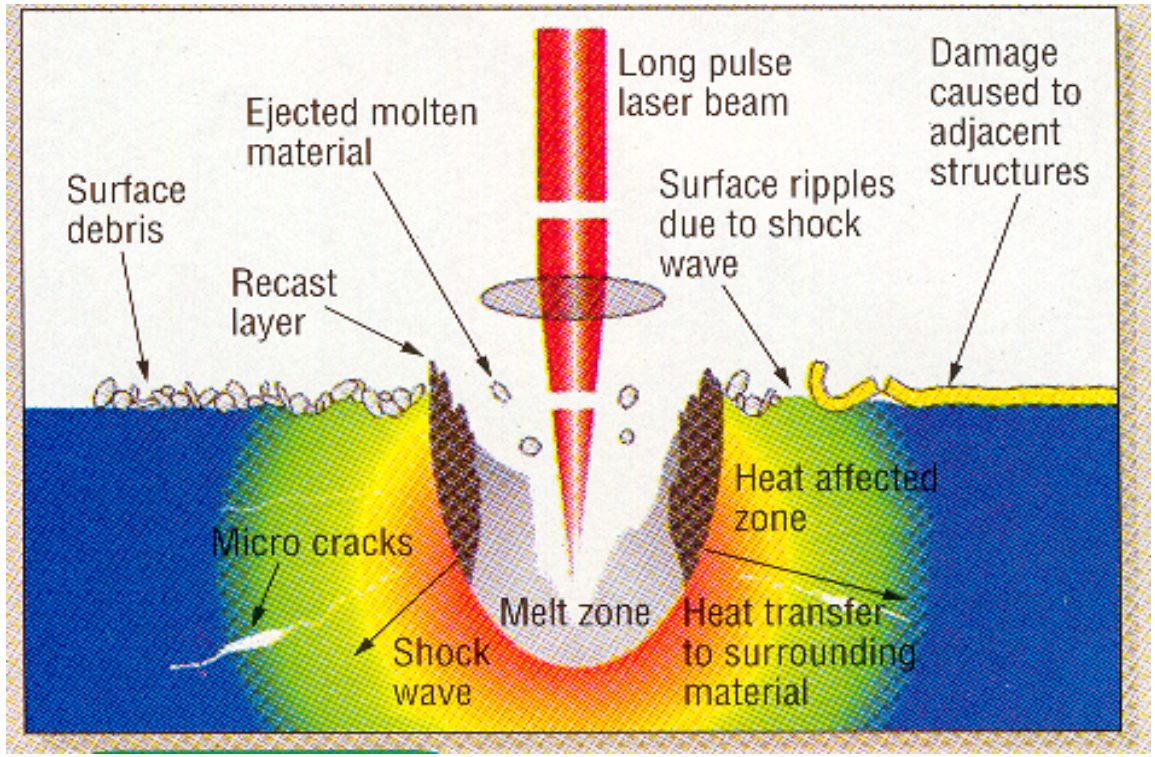
Laser- Drilling: Typical Side Effects





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Laser in Medical Industry
(Material Processing)

- Production-Equipment
  - Casting Moulds
  - Spinnerets
- System-Components
  - Electronic
  - Dosing
  - µ-Filter
- Instruments
  - Needles
  - Cannule/Tube
  - Endoscope Catheder
  - Saws
  - Forceps etc
- Implants
  - Stent/Hypotube
  - Seeds
  - Pacemaker
  - Transponder

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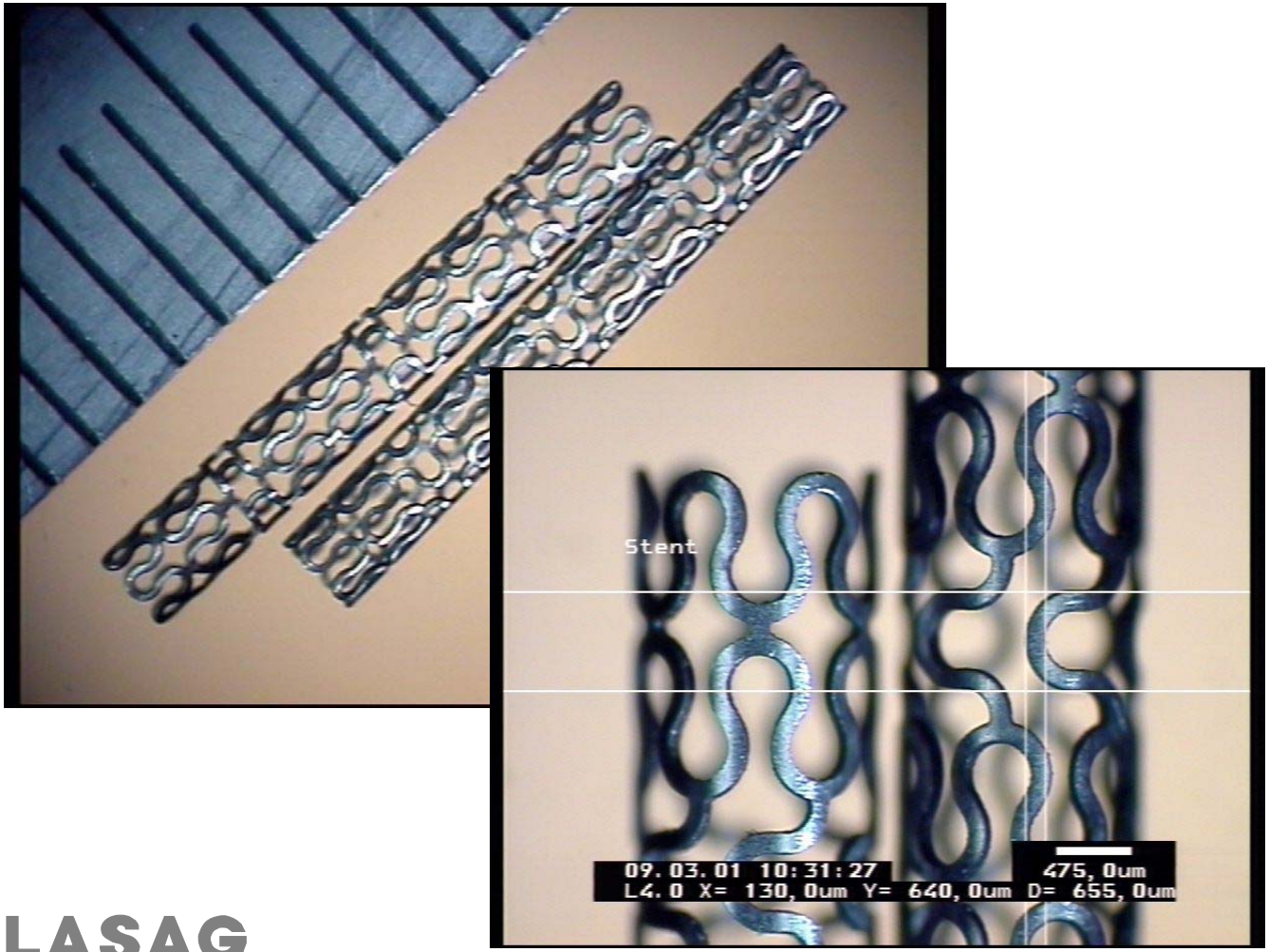
Cutting of Stents



Laser:
KLS 246 FC

Material: Steel, Nitinol
Wall-Thickness: 0.2 mm

Result:
Kerf width:
0.015-0.05mm
Speed:
> 200 mm/min
HAZ: < 0.01 mm

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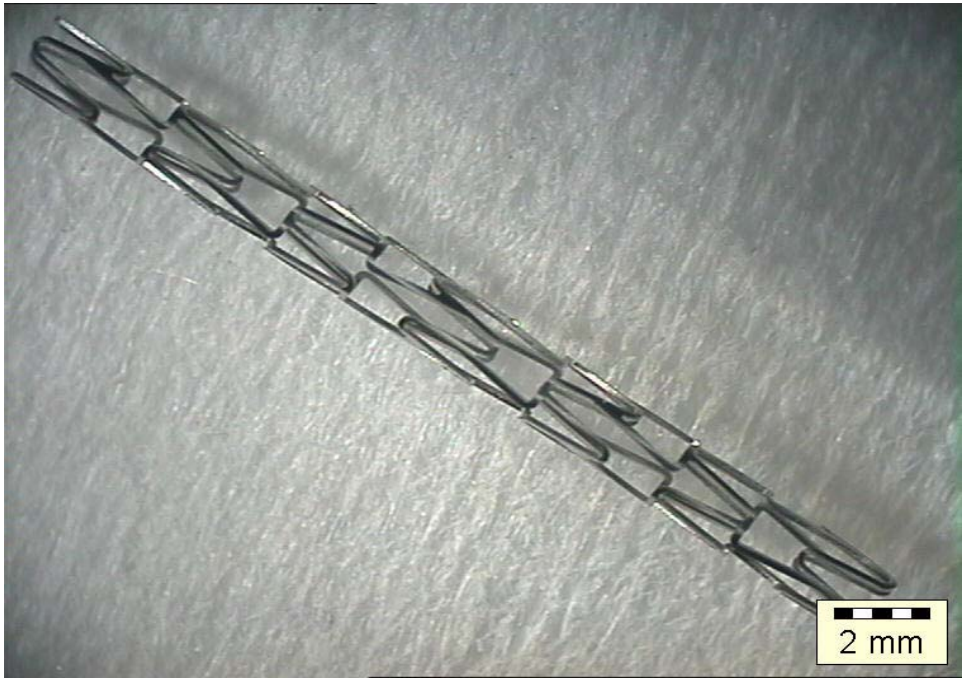
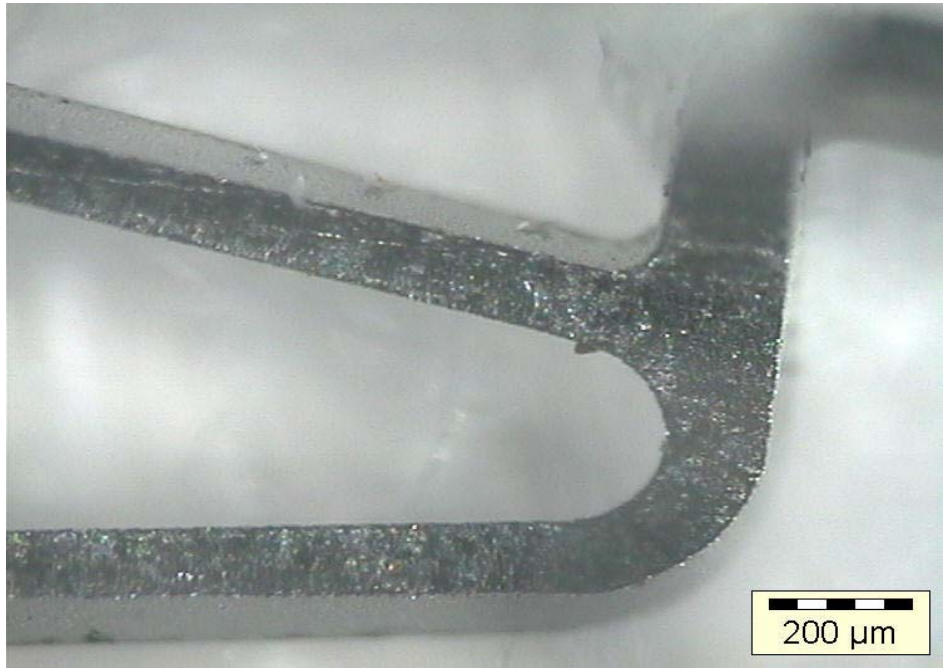
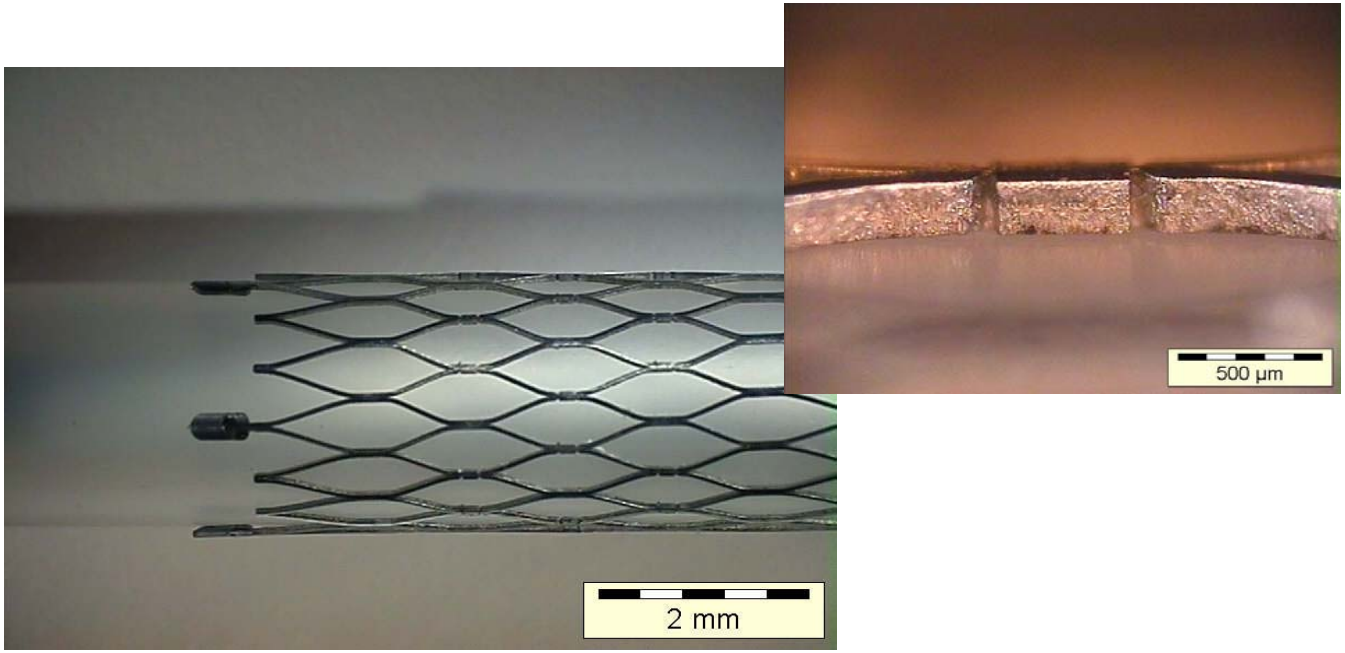
Cutting of Stents (S.St or Nitinol)



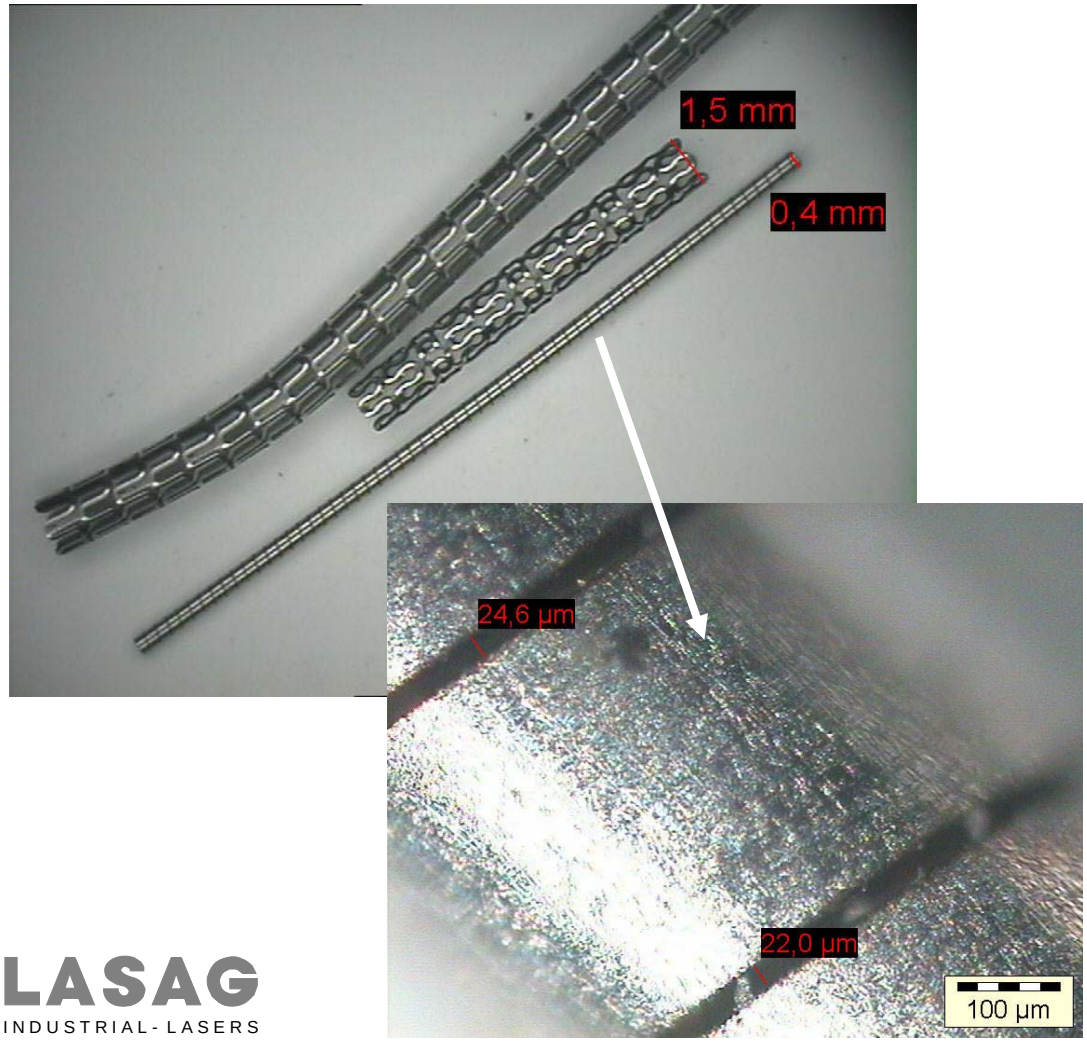


Cutting of Stents



Material:	*Nitinol*
Laser:	**KLS 246 FC**
Parameter:	*0.04 J Pulse energy,*
	500 mm/min Speed,
specs:	*crackfree, 10 µm gap*

Cutting of Hypotubes



Laser:
KLS 246-046FC

Material: S.St

Process result:
Kerf: 0.023mm
Speed: 200 mm/min
HAZ: < 0.01 mm

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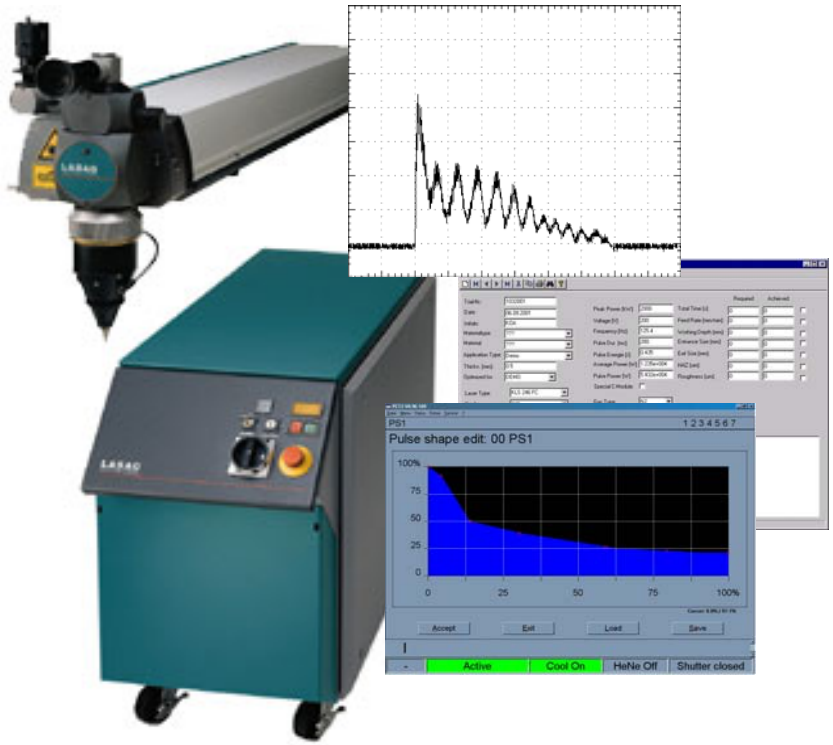
Welding of dissimilar biocompatible Alloys

Welding
Of S.St, Gold,Pt, Ti)



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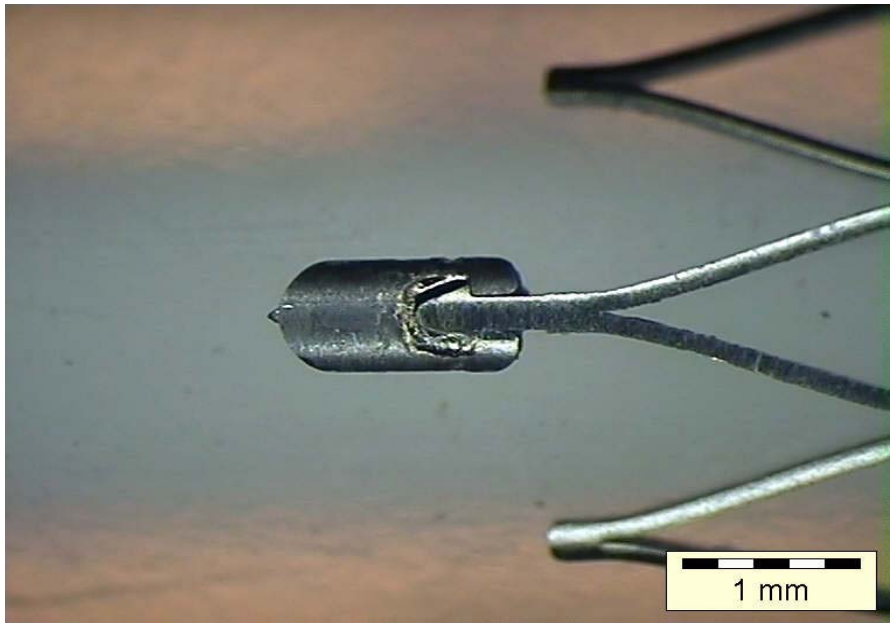
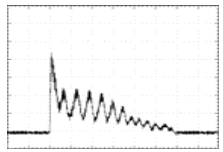
Welding Markers on Stents





Material: *Nitinol, Tantalum*
Laser: **Easywelder SLS 200 CL32**
Parameter: *0.065 J Pulse energy,*
100 mm/min Speed
Pulse form: *modulated, trailing edge*

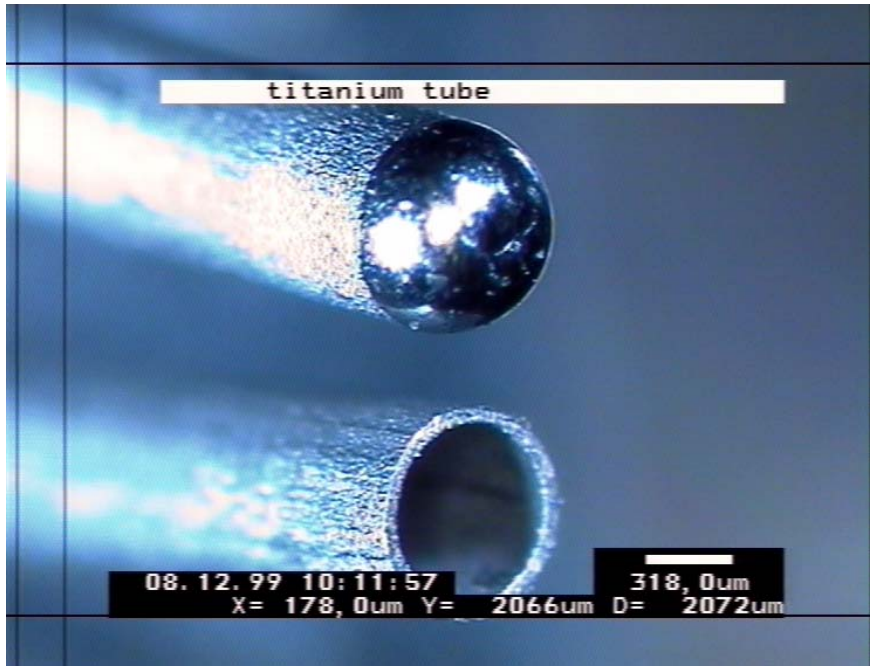
Spot Weld of Ti-Tubes (Seeds)

Radioactive Prostata Seeds

Ti housing

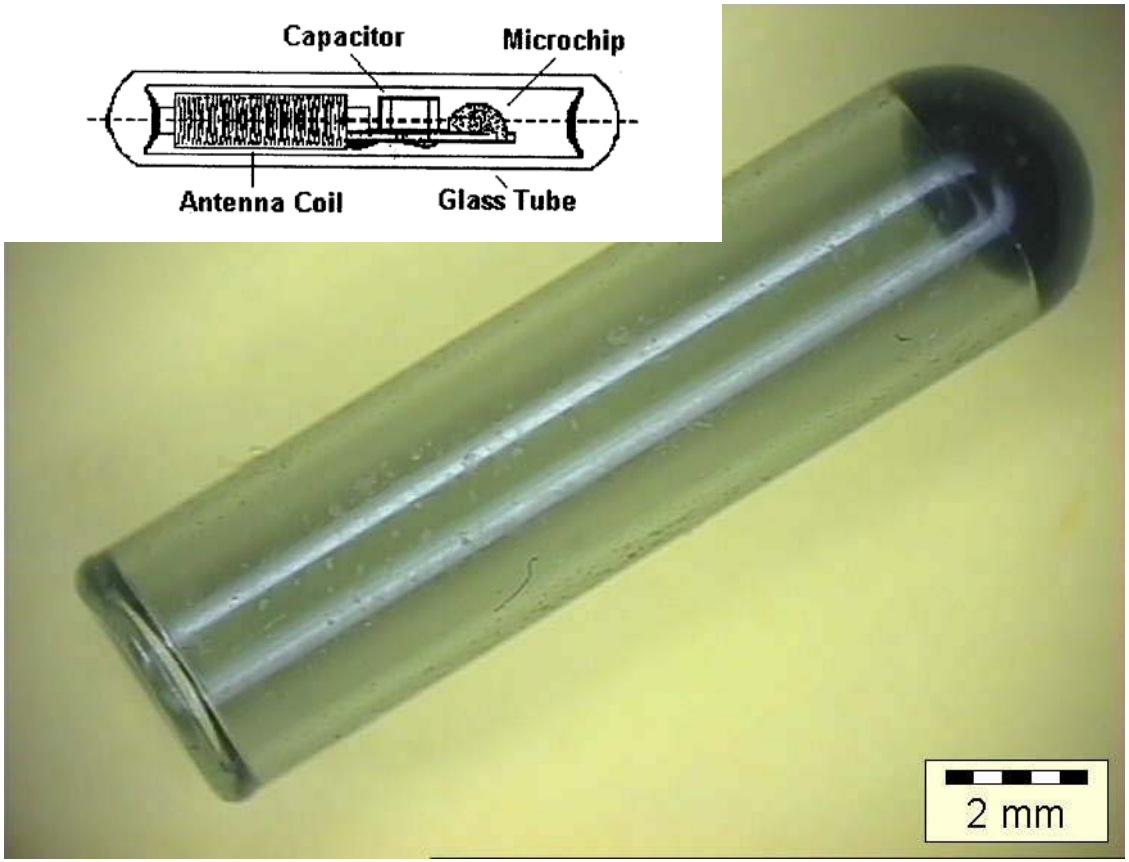
Silver Marker

Radioactive Implant (J124, Pd 103 decay 50 days)



Wall: 0.04mm
Diameter: 0.8mm

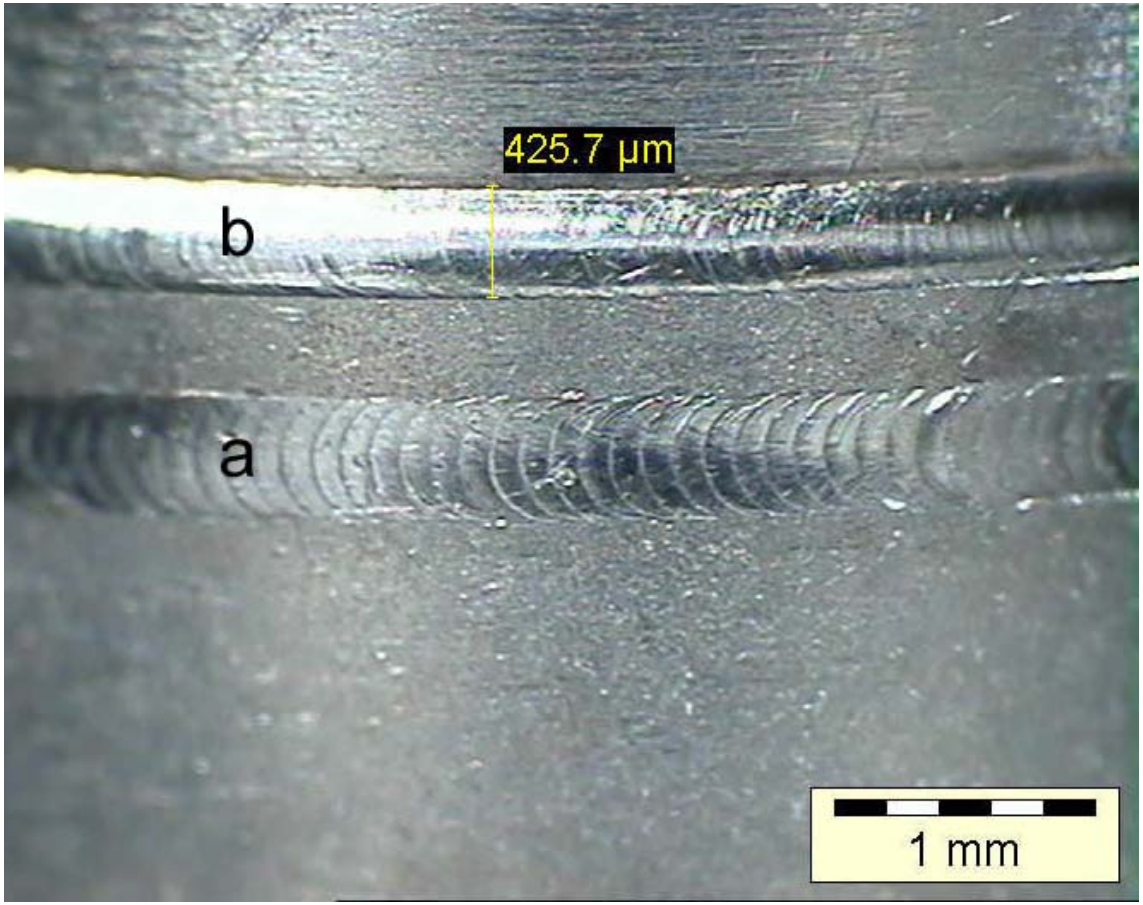
Laser cutting and sealing of Transponder

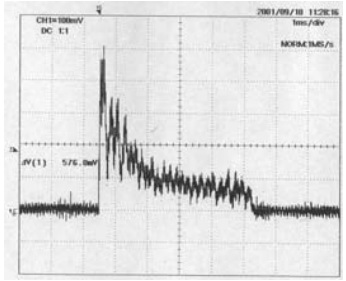


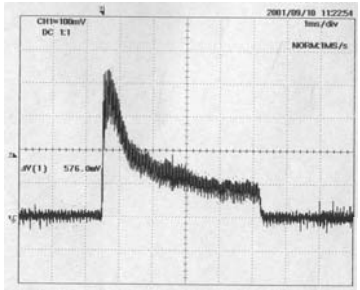
Material: IR-Glass

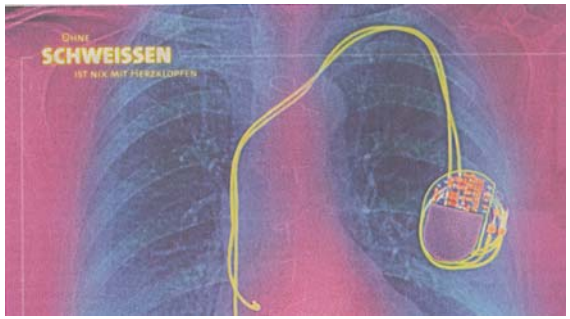
Processing result:
-Laserscribing and cracking
-Champering of entrance
-vacuum tight sealing

Ti- Welding

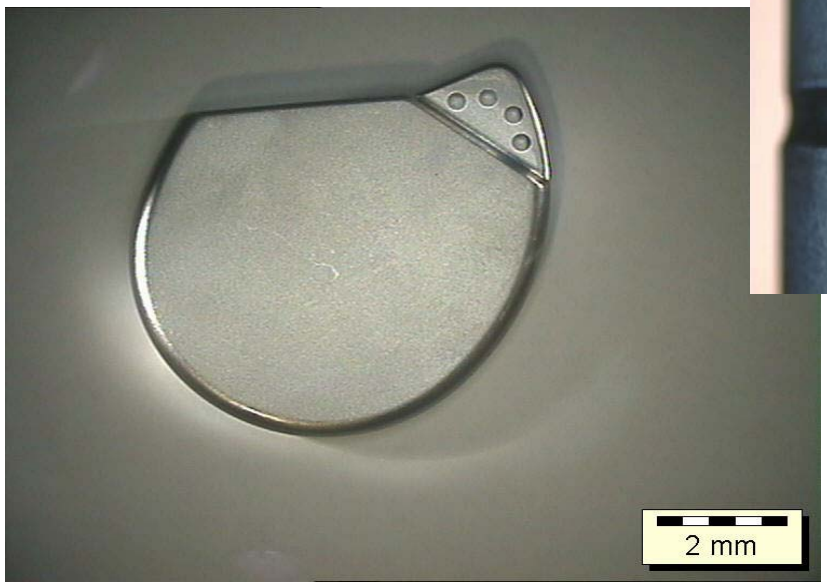


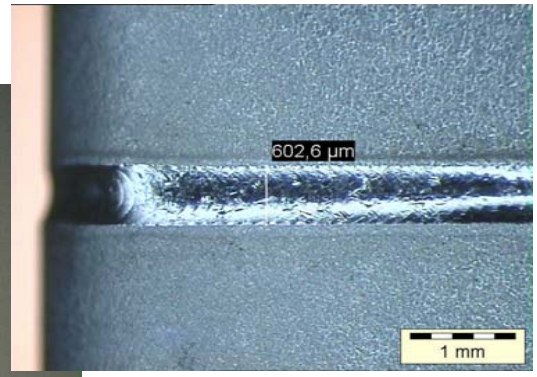


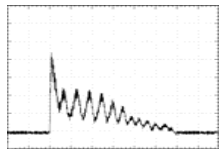




Welding of Pacemakers(Housing and Wirebonding)







Material: *Titanium grade 2*
Laser: **Easywelder SLS 200 CL60**
Parameter: *1.43 J Pulse energy,*
1200 mm/min Speed
Pulse form: *modulated, trailing edge*

Laser in Medical Industry
(Material Processing)

- Production-Equipment
  - Casting Moulds
  - Spinnerets
- System-Components
  - Electronic
  - Dosing
  - µ-Filter
- Instruments
  - Needles
  - Cannule/Tube
  - Endoscope Catheder
  - Saws
  - Forceps etc
- Implants
  - Stent/Hypotube
  - Seeds
  - Pacemaker
  - Transponder

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Cutting of Bone Saw

Quelle: LLT (Dr.Pause)

Laser:
KLS 246

Material: S.St
Thickness: 1.2 mm

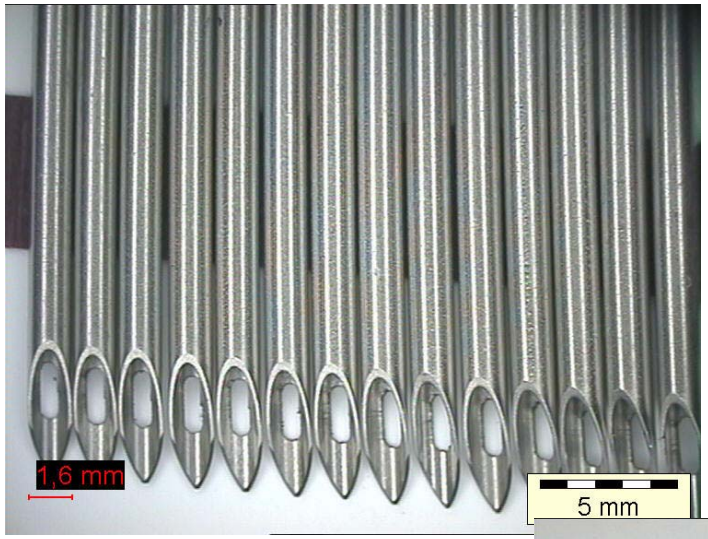
Process result:
Speed: 250mm/min (N_2)
Hardening of teeth

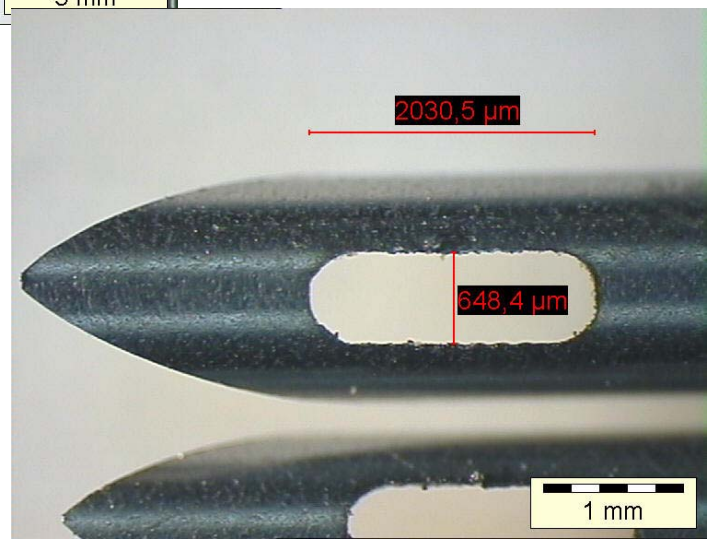
Ablation structure::
Less vibrations
Straight cut

Behaviour of Laser Cutted and Structured Saw

Quelle: LLT (Dr.Pause)

Cutting of Cannulas





Laser:
KLS 246-046FC

Material: S.St
Thickness: 0.1mm

Process result:
Time per piece: 2s
Kerf: 0.02mm
HAZ: < 0.01 mm

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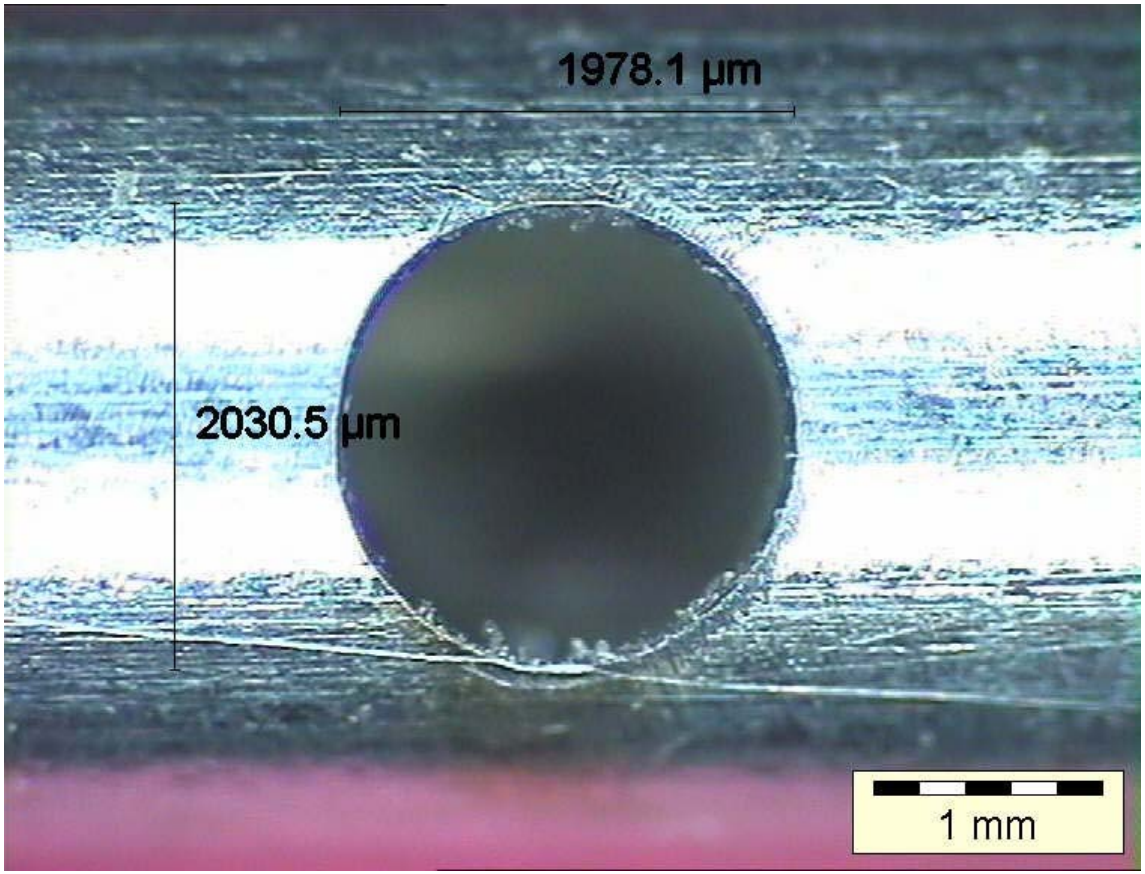
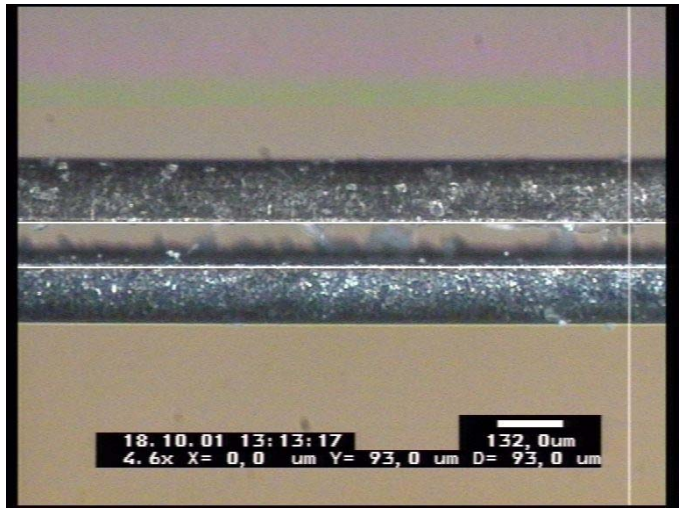
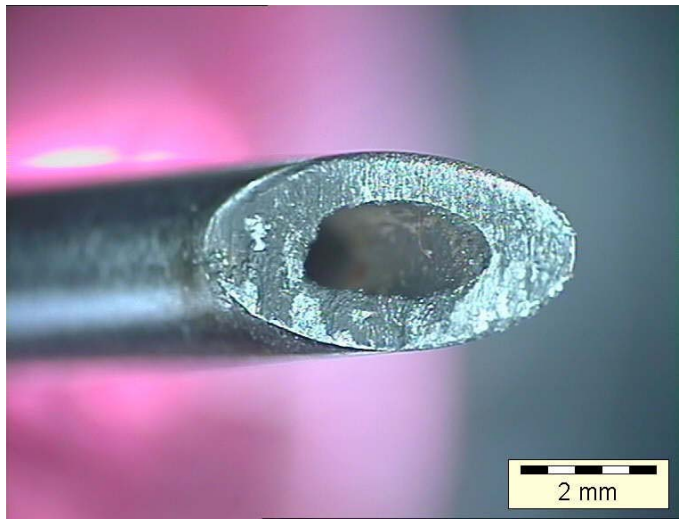
Cutting of Medical Tubes







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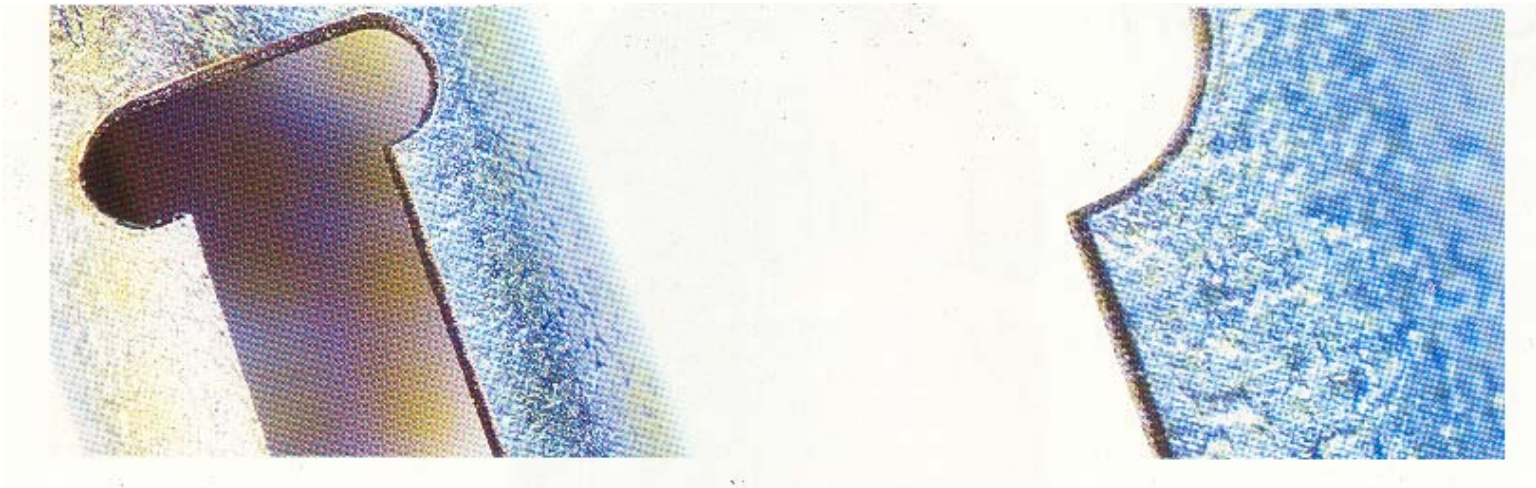
Cutting of Endoscope Parts



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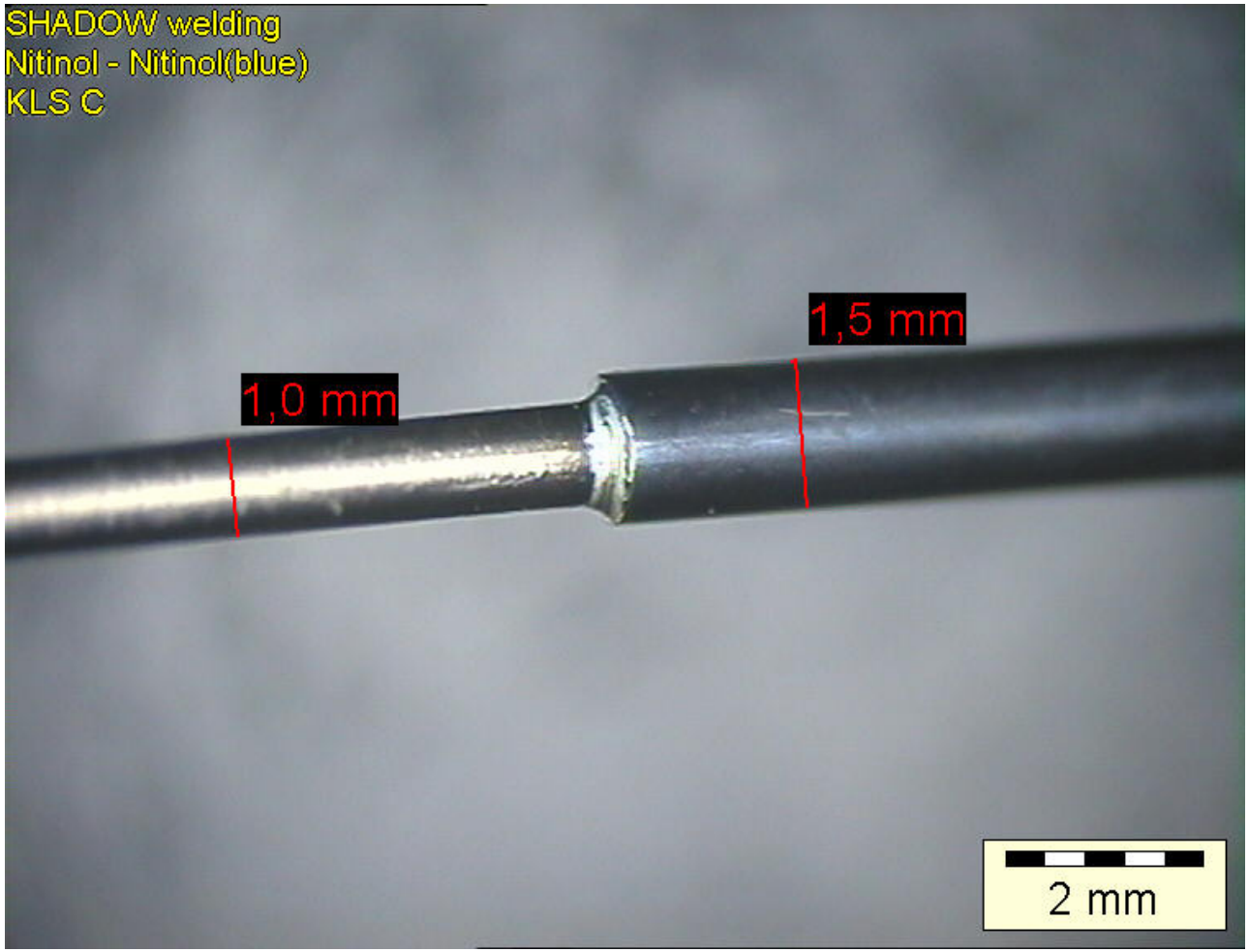
(SHADOW) Single Pulse Welding of Endoscope Tubes



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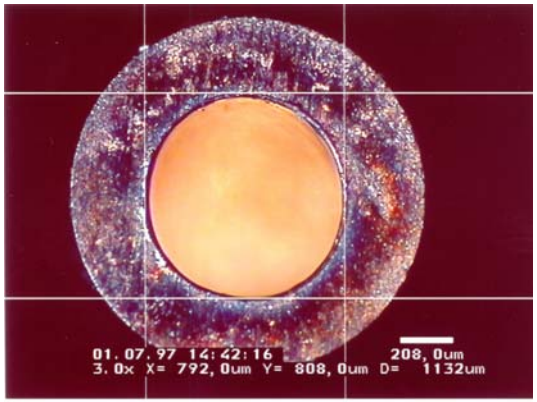
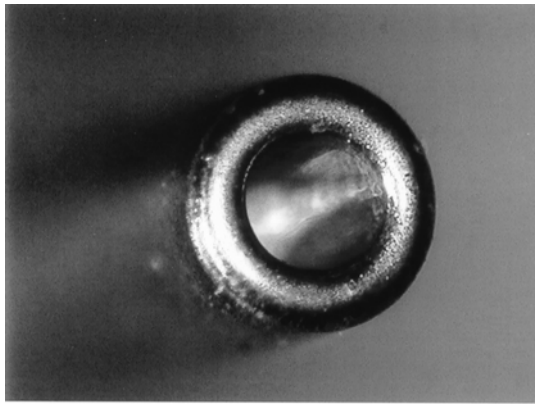
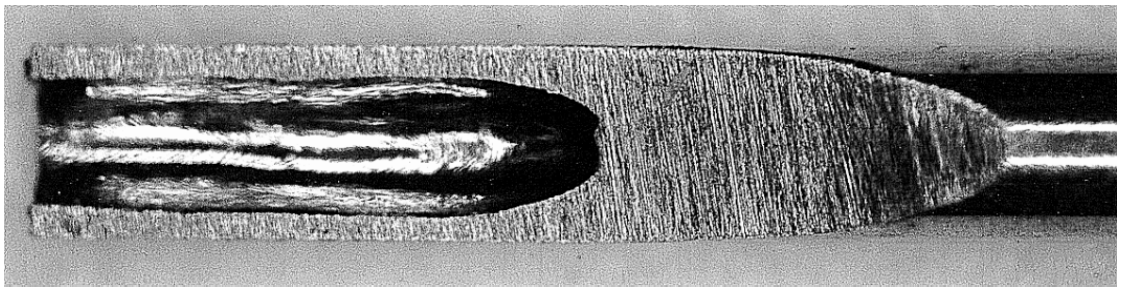
Laserdrilling, Annealing, Chamfering of blind Holes in Surgical Needles







Material: Stainless Steel

Process results:

Entrance: 0.05-0.4 µm

Entrance: rund oder scharf

Aspect: 1:4-1:8

Hardness << 400HV

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Summary:

Processing of biocompatible Materials
With the pulsed Nd:YAG Laser:

- Fine-/Precision Cutting with
Kerf <15µm und Aspect >10:1

- Fine-/Precision Drilling with hole-
Diameters <15µm und Aspect >15:1

- Precision Welding of similar and
Dissimilar function oriented metals
With new welding strategies with
High geometrical quality and low
Thermal side effects