Lasers In Medical Manufacturing
When, How, Why?

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Applications - Strength Welds

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Applications - Hermetic Welds for Implantables
Applications - Laser Cut Tubes

- Laparoscopy
- Gastrointestinal
- Urology
- Arthroscopy
- Wound Closure
- Ophthalmology
Science & Technology...

Science...
1917 Albert Enstein theorizes about "Stimulated Emission"
late 1950s Gordon Gould
Invents Laser
1960s Gas (Ali Javan), Diode (Robert Hall), Semiconductor (Nick Holonyak) Chemical (George Pimental)
1970s-Present Refinements and improvements

Technology...
1960s Investigations + early commercialization
1970s Finicky production-quality lasers
1980s Stable production-quality lasers
1990s Simplified production-quality lasers
2000s Technology driven cost reductions & improvements
What took so long?
Lag between science and application is unpredictable until technology is well developed.

Mass Use of Inventions
Years Until Use by ¼ U.S. Population

Courtesy of Ray Kurzweil and Kurzweil Technologies, Inc.
Why is laser right tool for the right job?

No physical contact

Precise, delicate, miniature - scaled to the device itself

Heat affected zone (HAZ) optically controlled (focusability)

Repeatable

Lends itself to validation techniques

In some cases, only tool available
Basic Techniques

Metal Cutting

Metal Welding (Spot and Seam)

Polymer Welding

Other Techniques: Surface Treatments, Marking, Deposition
Metal Cutting

Laser focused at surface. Nozzle or vapor pressure pushes molten material down and creates cutting kerf. Material ejected at bottom.

Advantages:
cleaner cut, uniform kerf
oxygen-free cut edges (use Ar or N cutting gas)
Lasers: CO2 or Nd:Yag, depending on material
Welding - Heat Conduction

Laser melts surface material and mixing is by liquid conduction. Joint made by solidified melt.

Suitable for thin materials with moderate structural stress.
Welding-Penetration

Similar to cutting. Vapor pressure of a plasma cloud cuts the material and equilibrium weld pool forms around plasma. Joint reforms behind light path. Light reflection pushes weld deep into material. Classic "nail head" joint shape.
Polymer Welding

advantages:
melt zone is buried beneath surface
as strong as ultrasonic welds
no microparticles created
lower HAZ, lower distortion

types of laser: diode (808, 940nm) or Nd:Yag (1064 nm)
Laser is just part of the solution

To use laser effectively, we need...

1. The right kind of problem to solve

2. The right kind of process control including ...
   facilities
   environment
   laser
   motion system
   fixturing and handling

3. The right training and support.
Applications

Cutting: Tubes, needles, surgical parts,

Welding: Medical electronics, implantable, surgical instruments

Marking: For product tracking, assembly, marketing

Combined applications: Using laser cutting to insure exact fit for welding.

New applications appearing all the time.
Process Considerations

Joint configurations

Part Fit

Part Alignment.

Controlling heat distortion

Cover Gas

Contamination

Materials

Develop a wide weld process window around specifications
Examples- Strength Welds

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Examples-
Hermetic Welds for Implantables
Hermeticity for Implantables

Rationale for hermeticity

Consequences of hermeticity on part preparation

Geometric challenges of medical implantables

Handling

Sterilization techniques

Testing hermetic seals
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Organizational Considerations

Levels of expertise required

Operational

Developmental

Maintenance

Quality

Trade secrets and confidentiality

Outside resources
Summary

Technology is well into adoption cycle

Established techniques solve problems shared by medical and other devices

Still a fertile area for application innovation

Trends toward miniaturization will continue to drive demand for laser solutions