TA201T: Introduction to Manufacturing Processes I

2020-21 Semester Summer

Template for Making Presentation based on Manufacturing Case Study

TOPIC NAME : Surgical Blades

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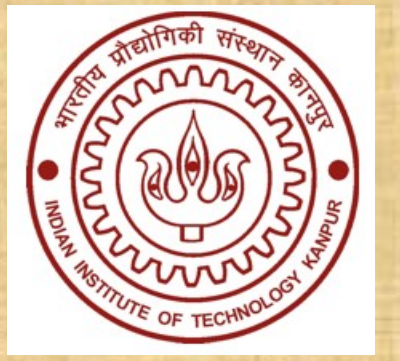


Outline

- **PART 1**
  - Introduction
  - History
  - Anatomy
  - Material selection
  - Types
  - Material structure (microstructure as well as shape & size) and Properties.
  - Advantage, Use, Disadvantage and Safety
- **PART 2**
  - Manufacturing Method.
  - Stainless steel
  - BMG Processing

PART 1

An Introduction to Surgical B

Surgical Blade are kind of tools that are often used in hospitals to perform surgery on patients.

The **disinfection** of these tools is a priority to ensure that patients do not have local infections and complications.

These are used for cutting skin and tissue during surgical procedures. There are different types of blades specific to the type of procedure. Surgical blades vary by size and shape. The number of the blade indicates the blade size and shape. Surgical blades are typically made with **stainless steel, carbon steel and Zr**-based **BMG.**

With the advancement of science and technology, new surgical cutting instruments have been widely used, and their cutting and hemostasis effects have been improved day by day, making surgical scars smaller and smaller, and promoting the rapid development of surgery.

A particularly well-preserved prehistoric blade mounted onto a handle was found in 1991, preserved in ice near the AustrianItalian border (see Figure 1)

In Rome, Galen and Celsus used an instrument with this shape—a small, sharp blade for specialized used for incision and drainage, tendon repairs, and vivisections (see Figure 2)

The requirements of antisepsis and asepsis in the late 19th century subjected instruments to caustic chemicals and pressurized steam sterilization, so nonmetallic decorations became obsolete (see Figures 3 and 4)

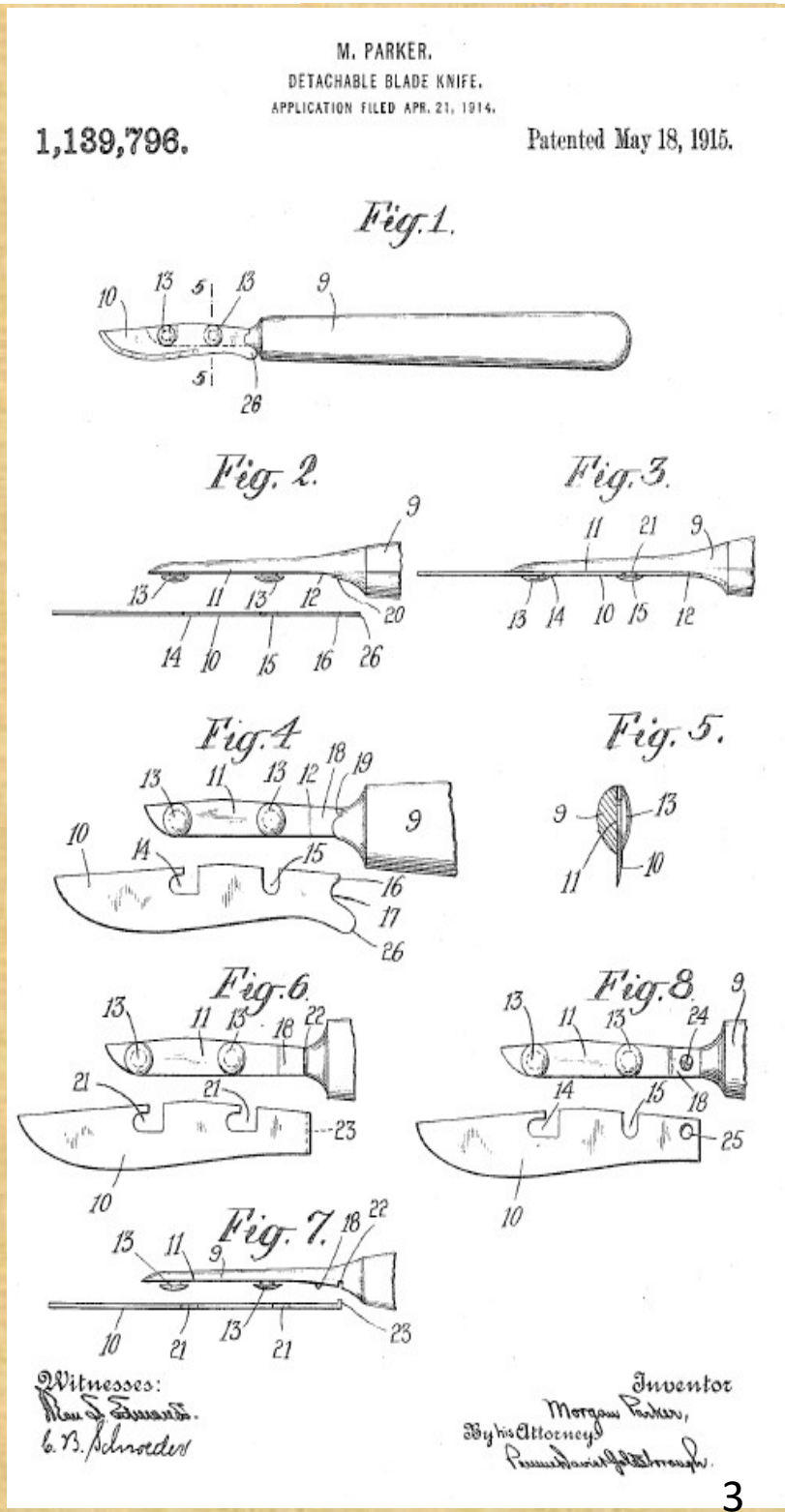
History

History

The traditional blade and scalpel shapes date back to ancient **Egyptian times** and have evolved overtime along with medical and surgical techniques

This frustrating cycle of events encouraged surgeons to use new safety razor blades (invented by **King C. Gillette founded** the American Safety Razor Company (later the Gillette Safety Razor Company) in 1901 to produce and market a handle-and-frame device that held disposable razors.) gripped in a haemostat or is a special holder designed by **John Murphy** (1857-1916). The blunt razor blades would be discarded and replaced with a fresh sterile one without delay thus initiating the disposable era.

In 1914, **Morgan Parker** (1892-1976), a 22-year-old engineer, invented the two-piece blade-and-handle medical scalpel that is used in ORs today. He heard of the issues through an Uncle and in 1915 proceeded to design and patent a two-piece scalpel with a metal handle that locked to a surgical blade.


M. PARKER.
DETACHABLE BLADE KNIFE.
APPLICATION FILED APR. 21, 1914.

1,139,796. Patented May 18, 1915.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4

Fig. 5.

Fig. 6.

Fig. 8.

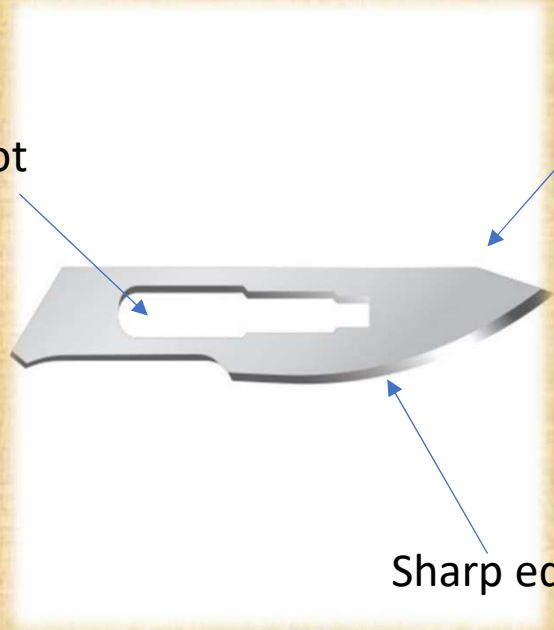
Fig. 7.

Witnesses:

Inventor
Morgan Parker,
By his Attorneys

Surgical blade anatomy

Scalpel is small and extremely sharp bladed Medical Instruments used for surgery or anatomical dissection.



Sharp edge: Belly	This is the cutting edge of the blade during surgery
Tip	The Sharp Tip of the blade used for slicing and cutting
Unsharpened ridge opposite to the edge: Spine	The Spine of the blade having unsharpened and rigid edge of the blade
Slot for scalpel	The arming and disarming assisted by the stabilizing gripping instrument

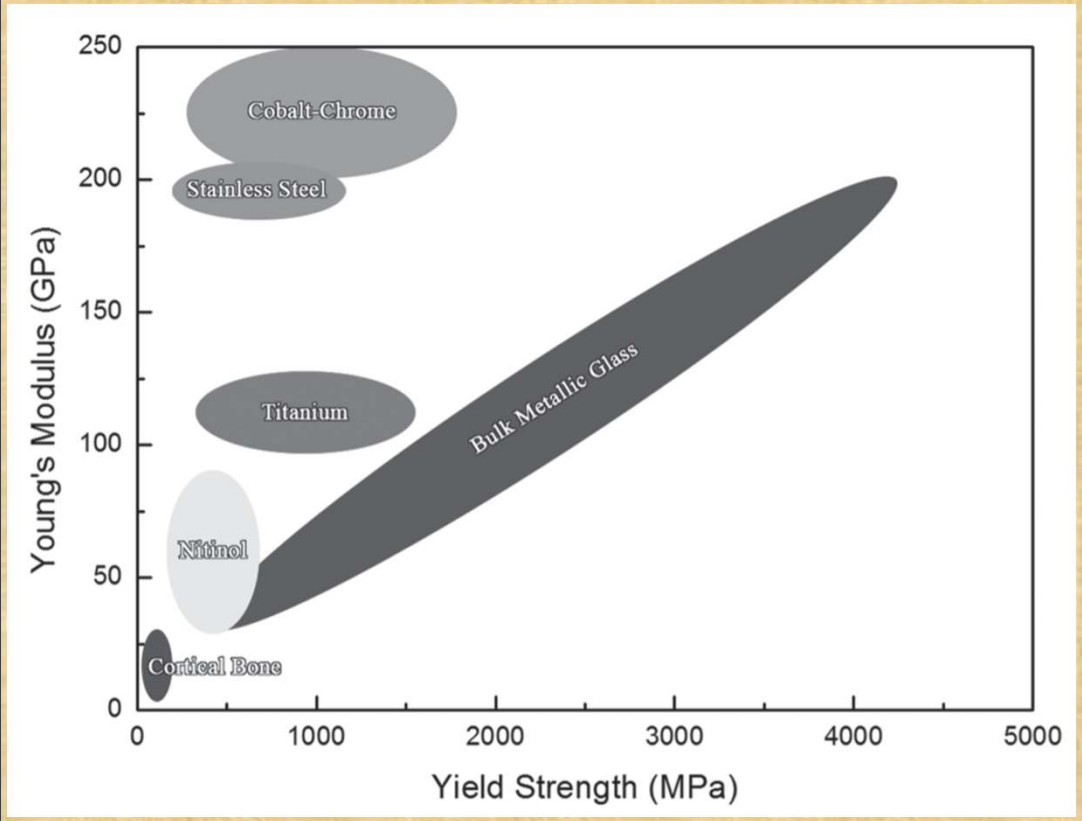
Surgical instruments made from Zr-based BMG

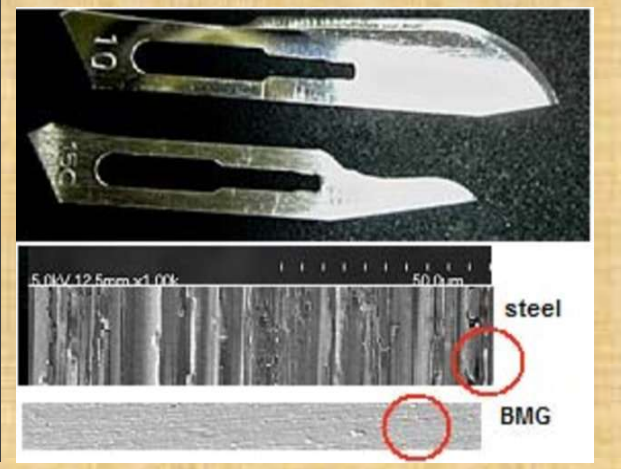
Medical and Surgical instrument are made from metallic alloys

- The traditional alloy is a polycrystalline material, and a significant body of literature exists describing, for example, innovations in the formulation and processing of **titanium- and cobalt-based** alloys for orthopedic applications

- **Bulk metallic glasses** (BMGs) are a relatively new class of metallic materials.
- Having a crystalline structure.
- It exhibit **no long-range atomic order**. Looks like atomically frozen liquid.
- In the last 2 decades, most metallic alloys that can form glassy solids have been developed across a broad range of compositions, including **Pd-, Pt-, Zr-, Fe-, Ti-, Mg-, Co-, and Au-**based systems.

Figure 1. Range of mechanical properties of metallic biomaterials





BMGs also show antibiotic effects

The influence of thermomechanical processing on microstructure development in surgical tools made of X20Cr13 steel

All Slice blades feature these properties:

- **Rust free**
- **Contain no metal**
- **Non-magnetic**
- **Non-sparking**
- **Non-conductive**
- **Chemically inert**

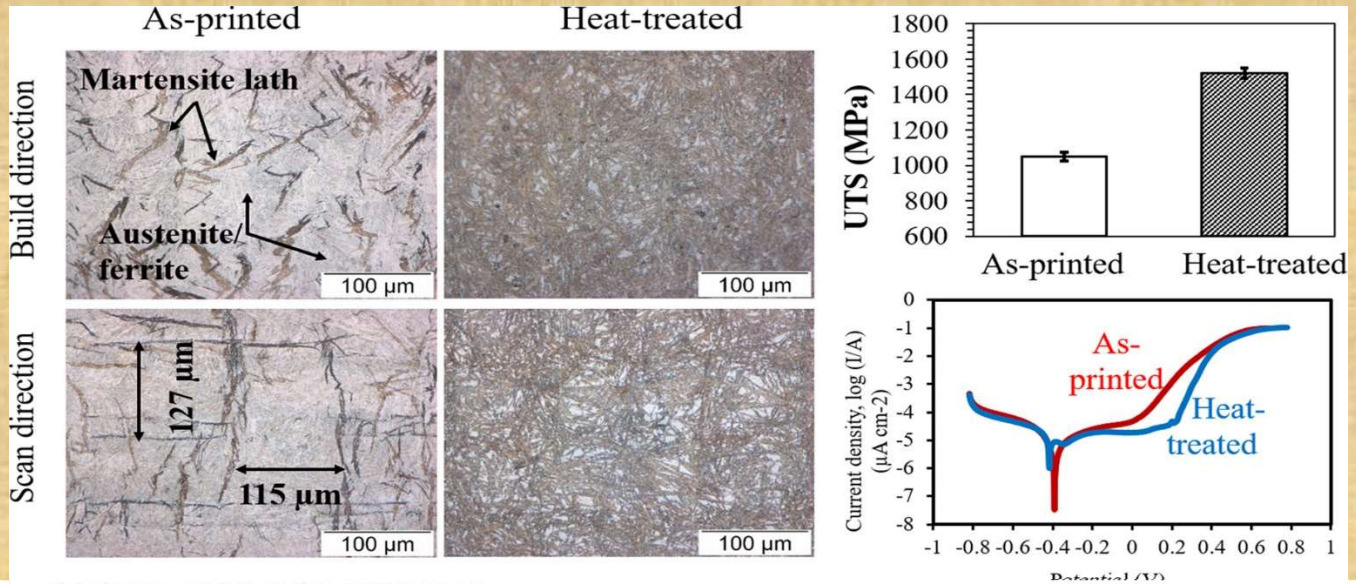


Table 1. Chemical composition (wt.%) of the investigated steel.

C	Si	Mn	P	S	Cu	Cr	Ni	Al_v	Mo	V
0.18	0.21	0.42	0.033	0.005	0.07	13.54	0.23	0.004	0.07	0.05

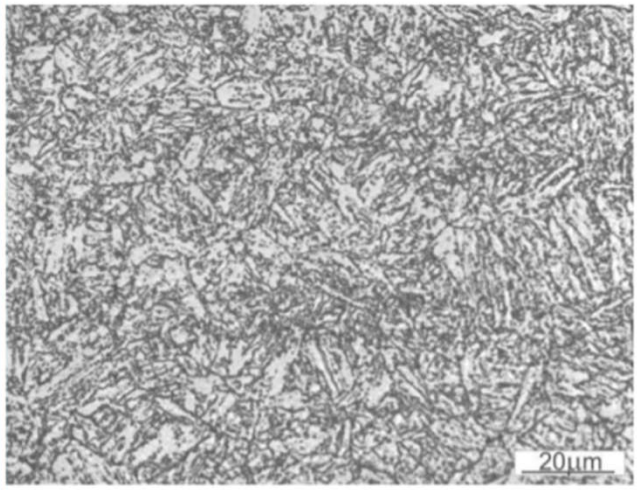
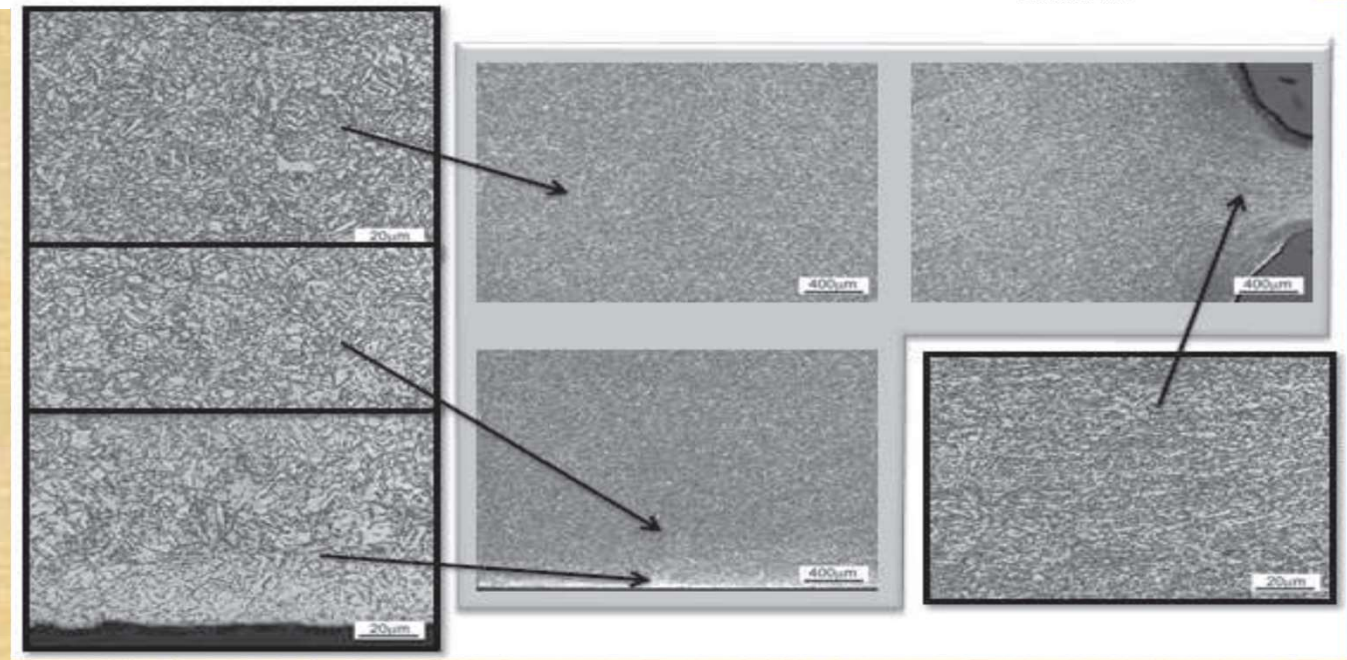


Figure 1. Microstructure of investigated steel in as-delivered condition. Light microscope.



Microstructure in the cross-section of Zr-Ca sample over Surgical blade.

TYPES OF SURGICAL BLADES.

Blade No.	Compatible Handles	Blade Description	Use
10	1,3,7	Curved cutting edge with flat back	For cutting skin and muscle in surgery, and for general carving and stencil making;
10a	3,3L,3 Graduated ,5B,7,9,B3,B3L	This blade is a small and straight	also can be used for removal of 'edge beads' from photolithography resists
11	1,3,7	Triangular blade with sharp point, flat cutting edge parallel to the handle and flat back	For precision cutting, stripping, sharp angle cuts and stencil cutting due to its similarity to the X- Acto artknife blade
12a	3,7	A small, pointed, crescent-shaped blade sharpened on the inside edge of the curve	

Advantages/Use- of Scalpel

- It is use to cut and reflect the skin.
- It is used to cut the Tissues and dissection of though connective tissues
- It is used to divide the vessels, pedicels and other structures.
- It is used for the sharp dissection.

Disadvantages- of Scalpel

- It may cut or injure the important structure during dissection.
- Sharpness of the blade required
- frequent sharpening.
- Once Sharpness is gone we have to use a new Blade.

Safety Scalpel

•Never use a scalpel blade without a handle

•Don’t leave blades out after use

•Don’t use excessive force or a sawing motion when using a scalpel

•Use a disposable, fixed blade scalpel when possible

REFERENCES

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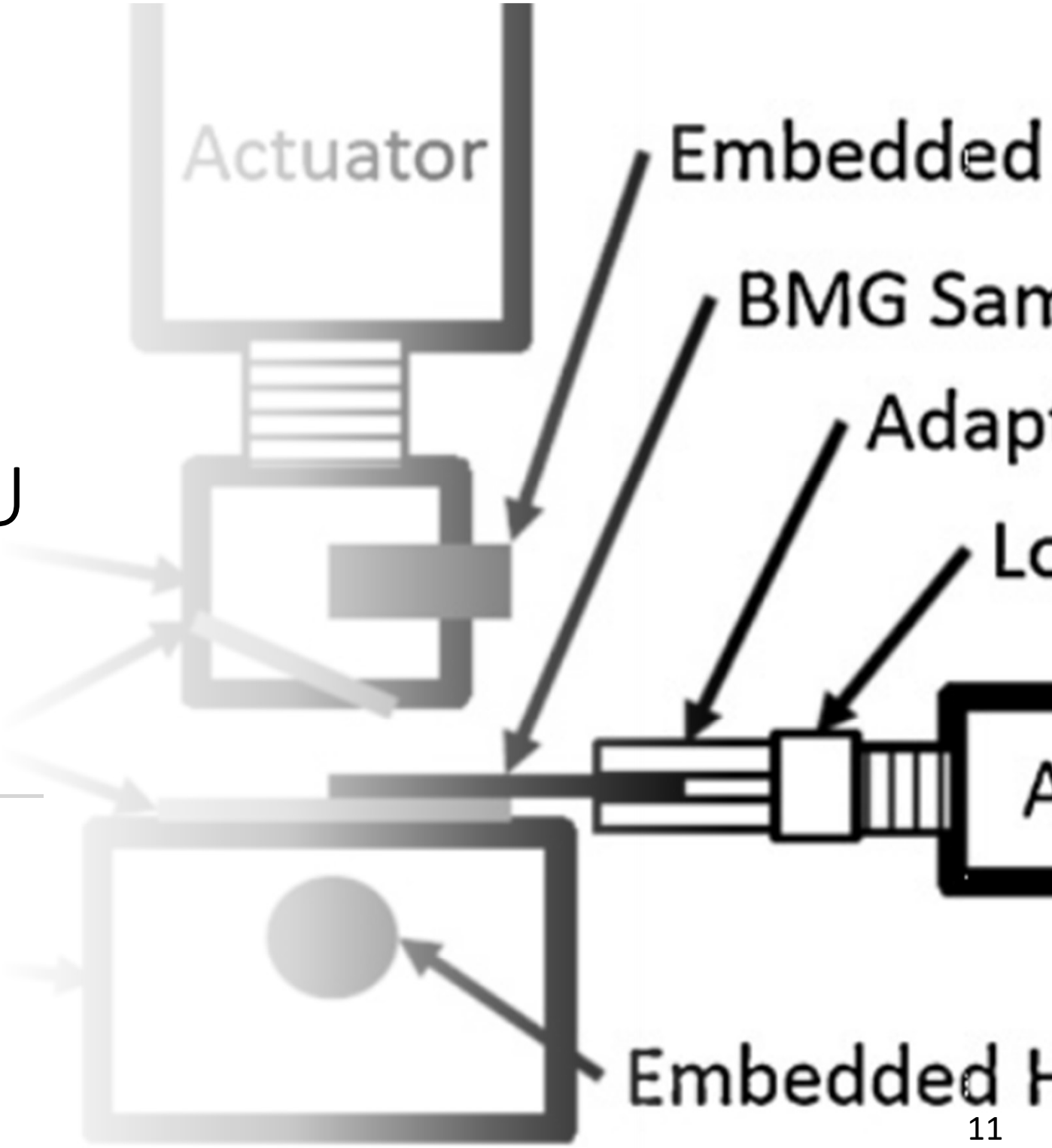
- 2012 Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim Paper A and B
- Microstructure-property relationships of 420 stainless steel fabricated by laser-powder bed fusion
- Recent Progress in the Industrialization of Metallic Glasses
- http://www.fosmedic.com/news/Introduction-medical-Surgical-Blades-185.html
- https://www.swann-morton.com/faqs/history
- From Book chapter:
- Journal of cutaneous and aesthetic surgery **Year** : 2018 | **Volume** : 11 | **Issue** : 2 | **Page** : 79-82
- SURGICAL BLADES: WHICH SCALPELS ARE RIGHT FOR YOUR OPERATING ROOM?
- Safety https://www.youtube.com/watch?v=vxLaetjvKsk&feature=emb_title

PART 2

- Processing Details
- Explain the all-processing routes by which the component can be made
- Describe the effect of varying processing parameters on the microstructure and properties of the particular material system

SURGICAL BLADE MANUFACTURING METHOD

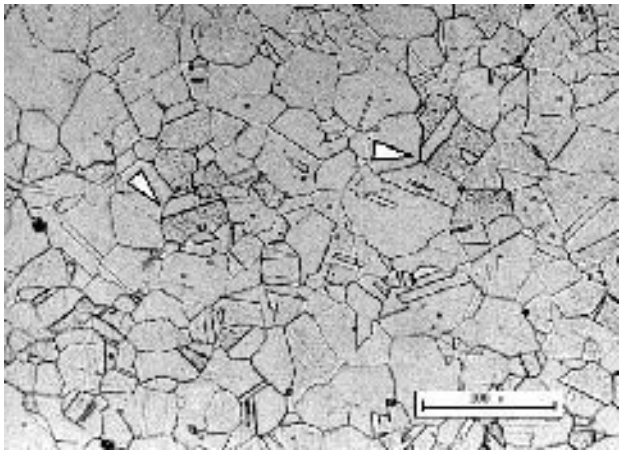


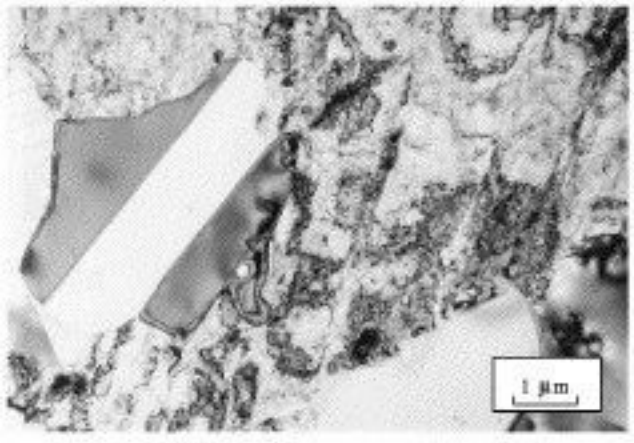
Material used in Surgical Blade and Its Properties

Austenitic stainless steels

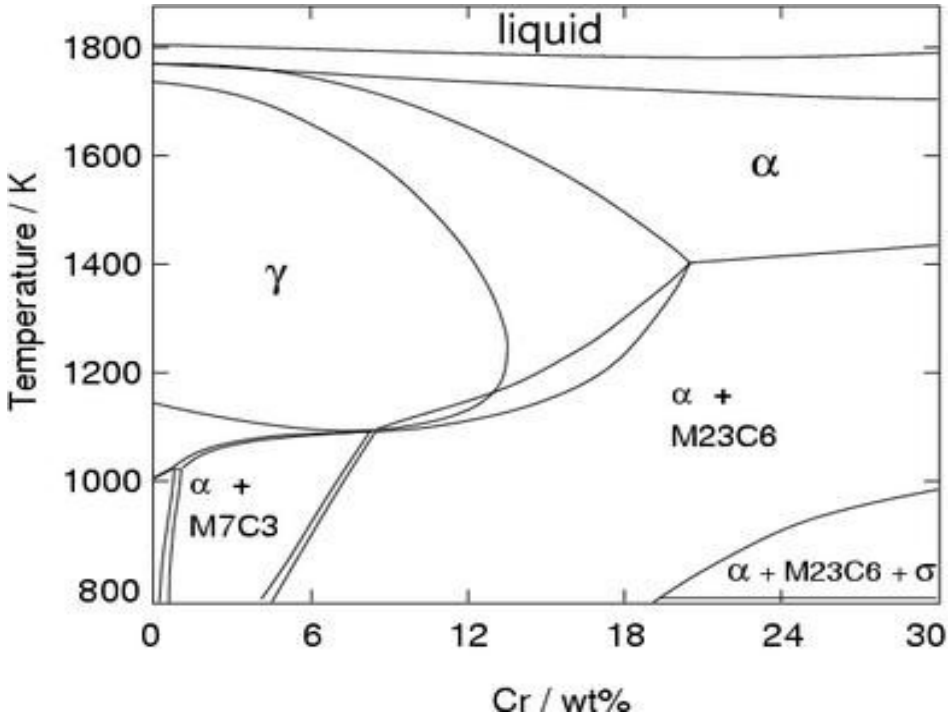
1. Cr equivalent = (Cr) + 2(Si) + 1.5(Mo) + 5(V) + 5.5(Al) + 1.75(Nb) + 1.5(Ti) + 0.75(W)
2. Ni equivalent = (Ni) + (Co) + 0.5(Mn) + 0.3(Cu) + 25(N) + 30(C)

austenite stabilizers

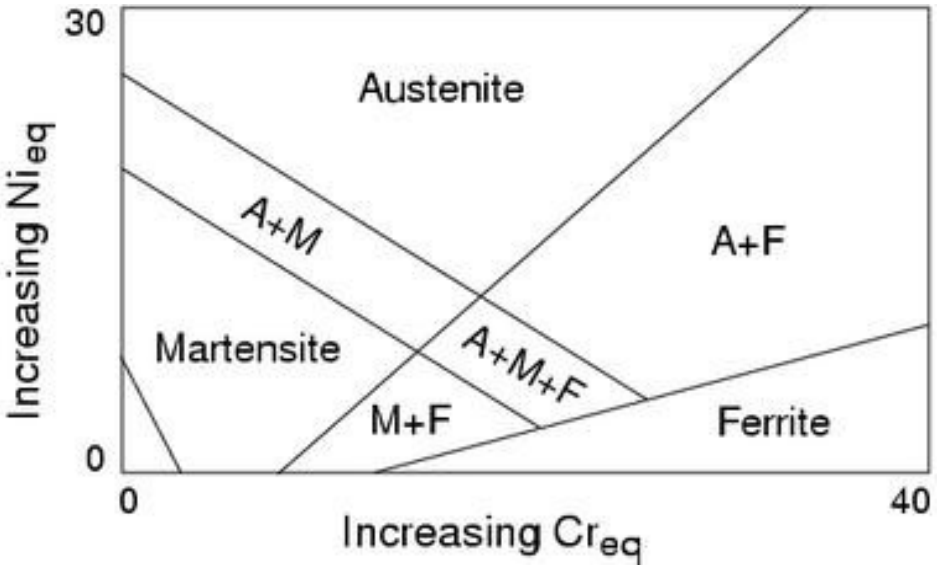




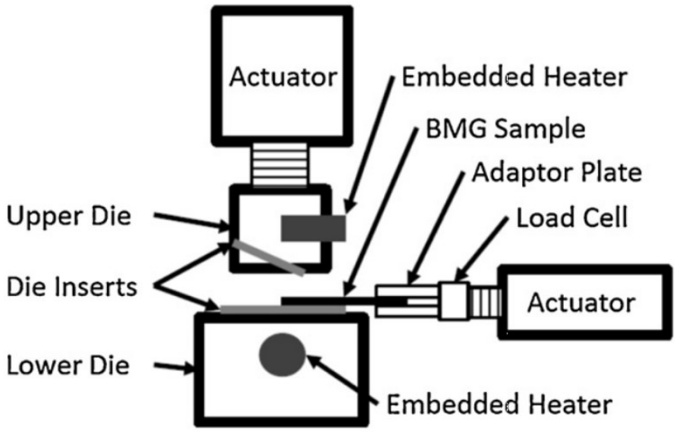
Vertical section of Fe-Cr-C diagram for 0.1C wt%



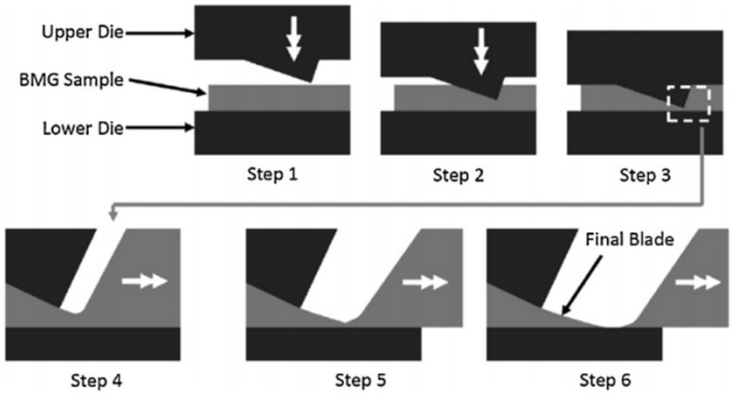
Schaeffler diagram for weld metals.



Bulk metallic glass Process

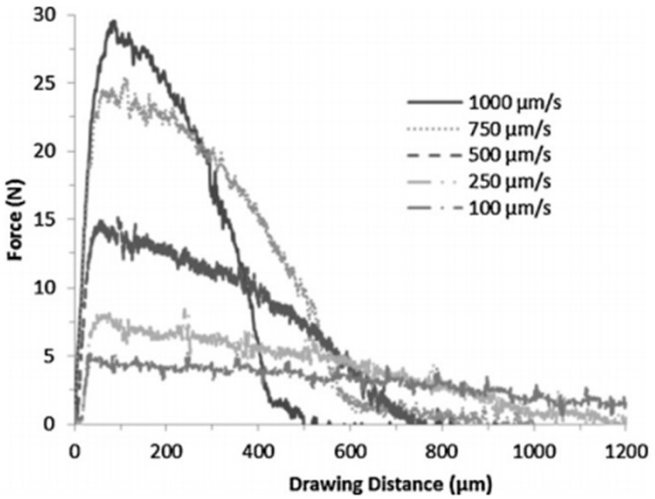


Hybrid manufacturing process testbed



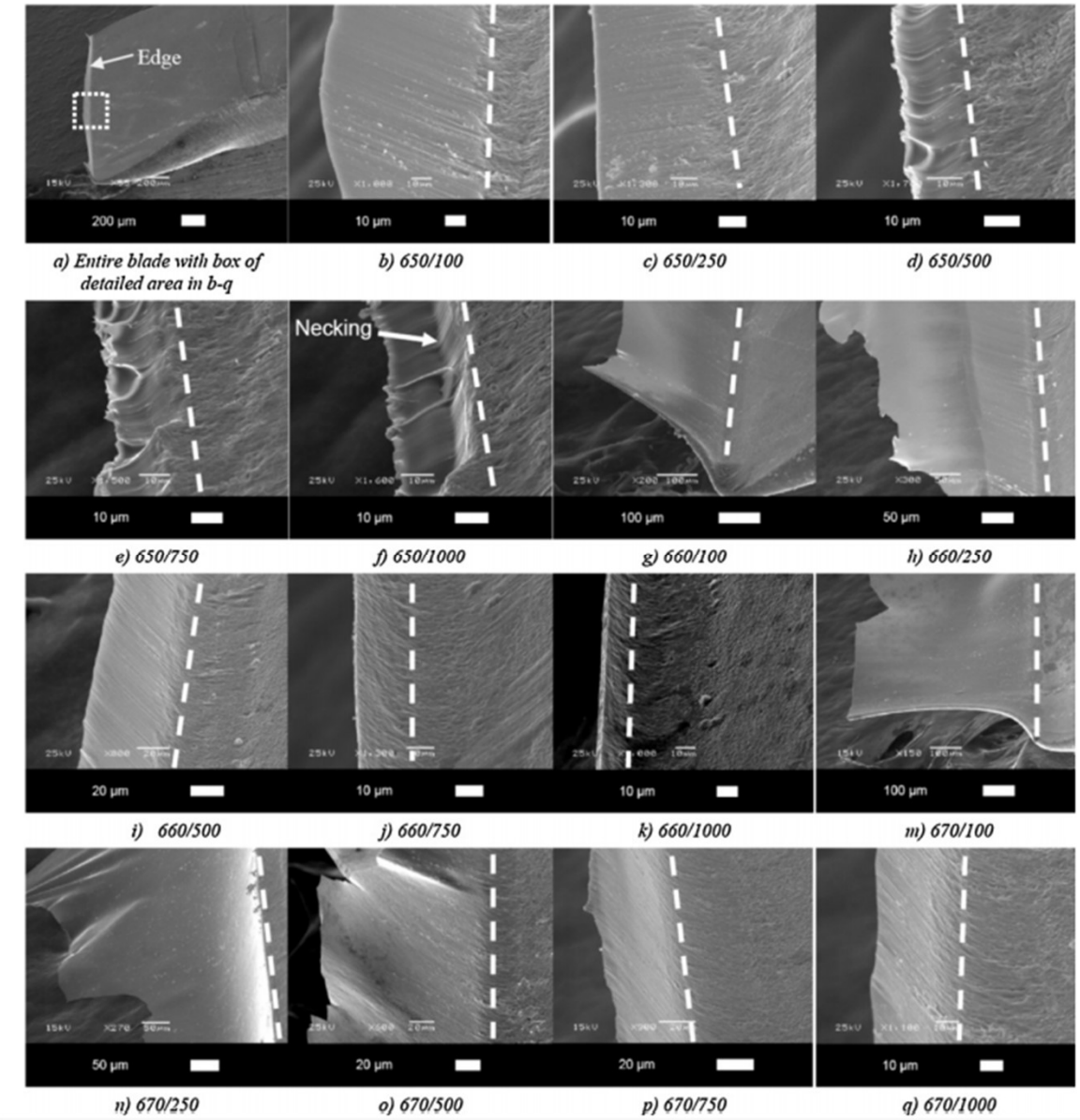
Hybrid manufacturing process (final blade on left).

- Bulk metallic glasses were originally discovered in the 1960s when a binary Au–Si glass metal was created.
- However, not until the early 1990s have more stable multi-component alloys with lower critical cooling rates been found. Vitreloy-1, developed by Liquid Metal Technologies [8], is a **zirconium-based bulk metallic glass** with the chemical formula: **Zr41.25Ti13.75Cu12.5Ni10Be22.5**.
- The BMG samples were **40 mm × 2 mm × 500** m (L ×W× H). Multiple tests were run along the length of a sample, each test producing final blades roughly **3 mm × 2 mm × 500 m.**
- The upper die was stopped at a gap thickness of 20 m for all tests. Using a 500 N load cell, drawing force data was recorded to quantitatively analyze the deformation occurring in the sample.
- Additionally, a camera with a **200×** microscope lens was used to provide a video record of each test in order to help visualize the deformation occurring during the test.



Force vs. drawing distance for 670K.

- ✓ As feed-rate increases, the peak force for all the temperatures increases, but the drawing distance until failure quickly decreases
- ✓ The feed-rate increases the shape of the plot shifts from an almost flat line, to a gradual drop off, to eventually a quick rise and fall at the highest feed-rates and lowest temperature.
- ✓ The dependence of the material properties on both temperature and strain rate, it is possible to realize similar force responses at different combinations of temperatures and feed-rates.

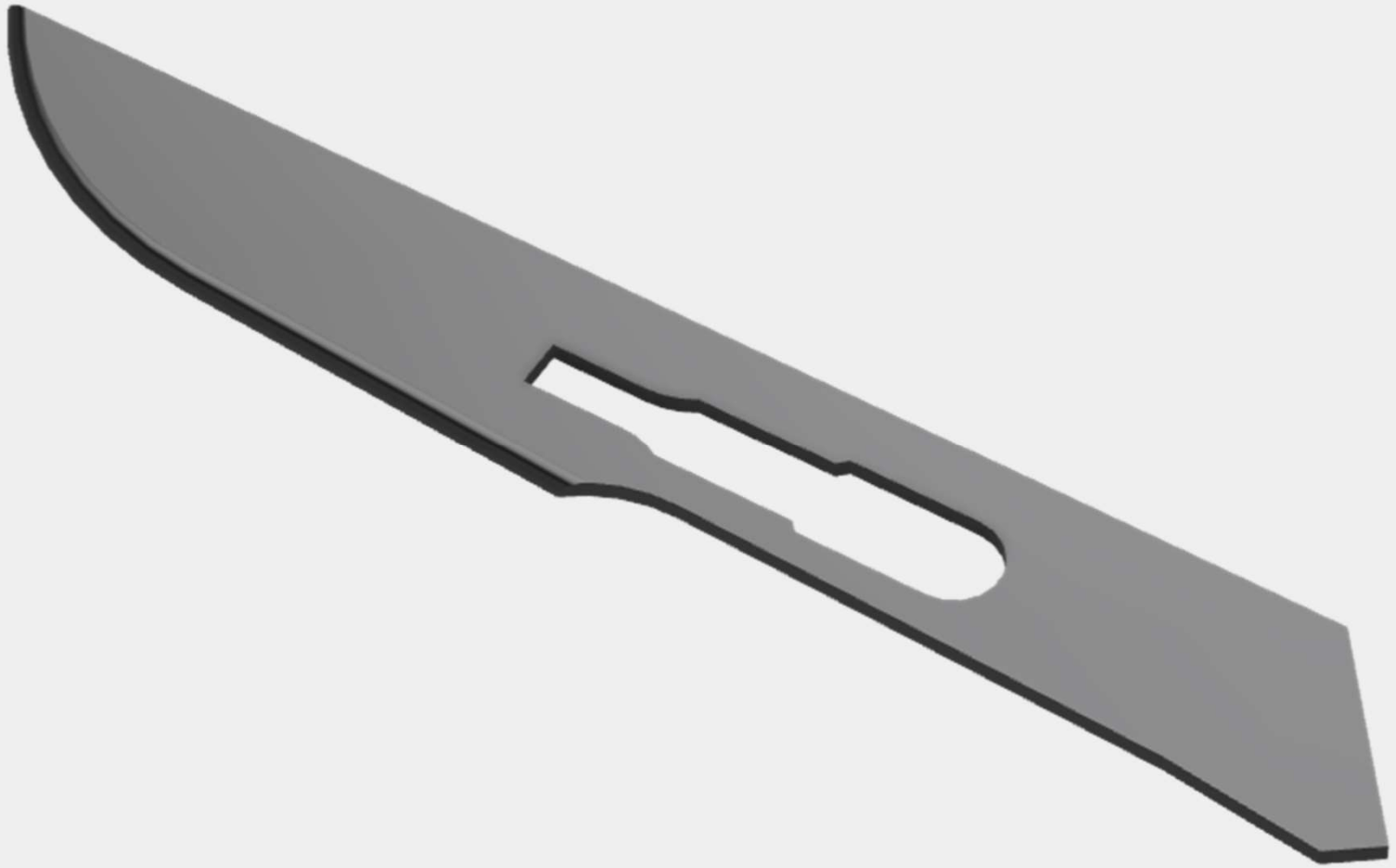


SEM images of edge deformation: temperature (K)/feed-rate (m/s), dotted line marks the start of deformation

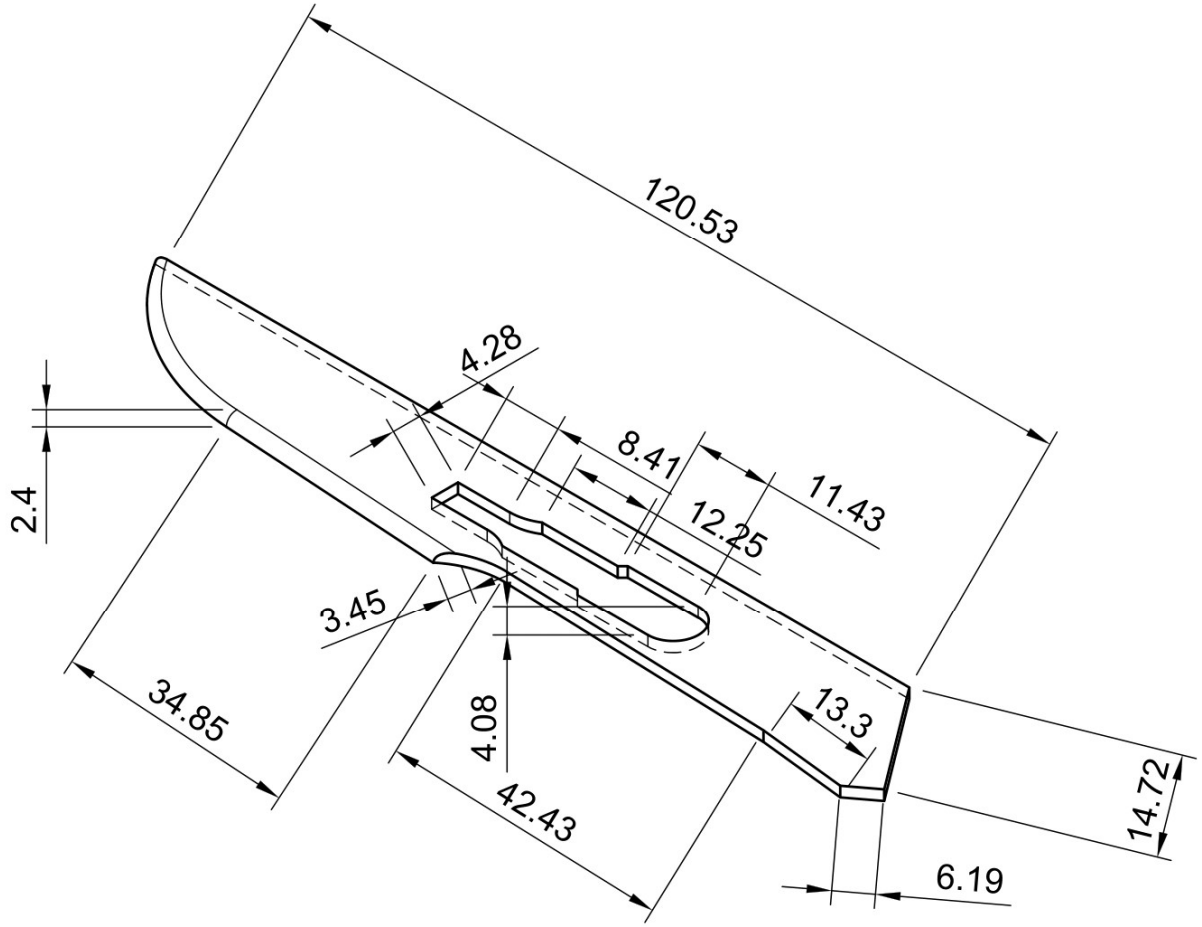
Outline

- **PART 3**
  - 3D View
  - Isometric View Dimensional
  - Sectional and projected view
  - Carbon and Steel
  - 1. Microstructure
  - 2. Macrostructure
  - Types of blade
  - Raw Material
  - Product
  - Process
  - Safety
  - **Information @ a Glance**

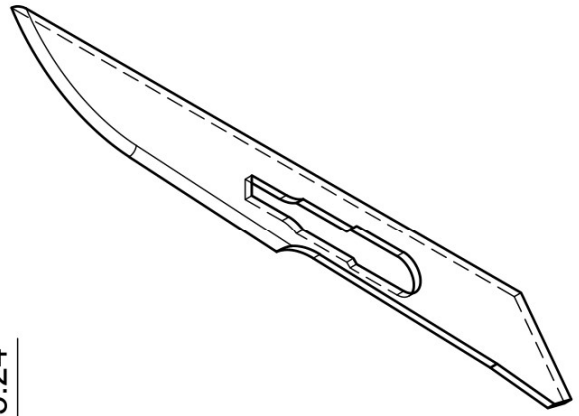
3D View Made by Vikash Meghwal 190966



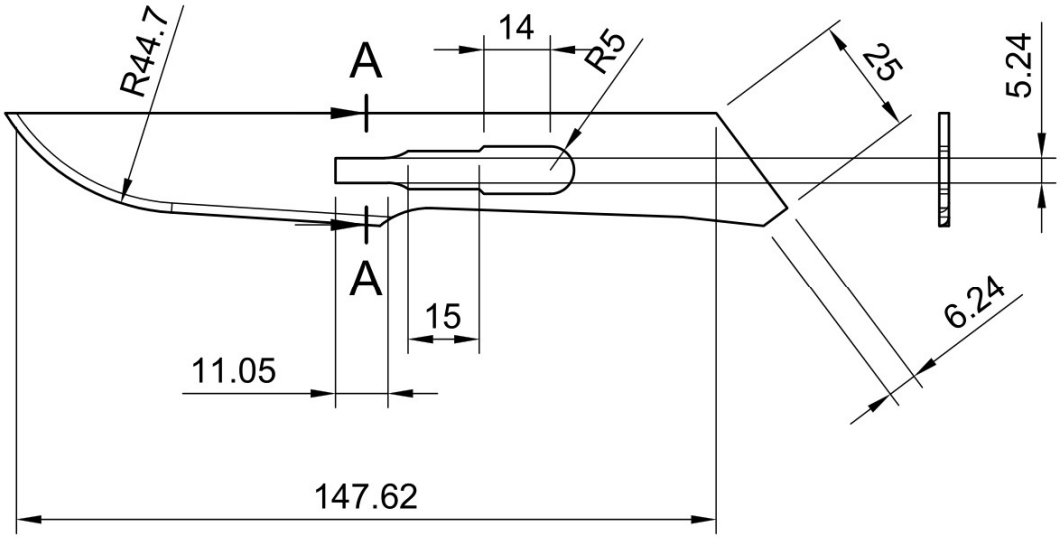
Scalpel Surgical Blade



Dept.	Technical reference	Created by Vikash Meghwal 2-Jul-21	Approved by
		Document type Scalpel Surgical Blade	Document status 3D Construction
		Title Blade Projected View	DWG No. 1
			Rev. / Date of issue: 2-July-2021 / Sheet: 2/2



A-A (1:1.5)



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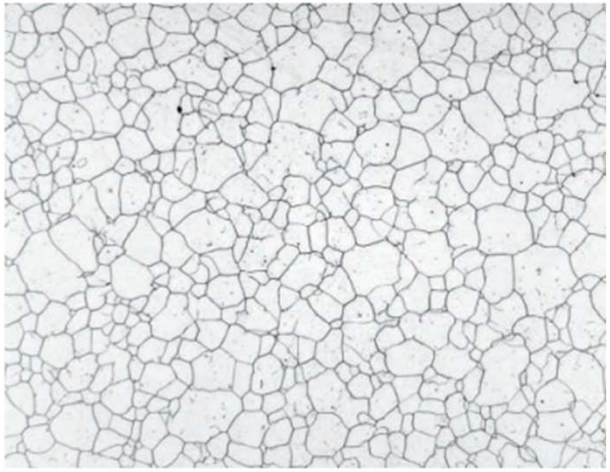
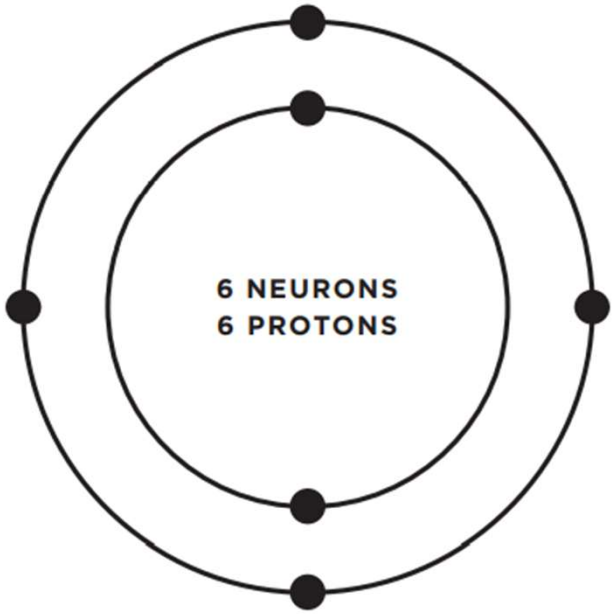
			Rev. / Date of issue 2-July-2021 / Sheet 1/2

Carbon and Steel Microstructure



As metal solidifies, atoms arrange themselves into rows. This process happens in many different places all at once. Wherever these separate rows touch, boundaries are created. These create the “grains” in metal. Grain consistency is important to maintain when making a knife. If your grain size is inconsistent, the steel is prone to warping and non-uniform hardening.

The grain microstructure of steel. The visible lines are the grain boundaries.



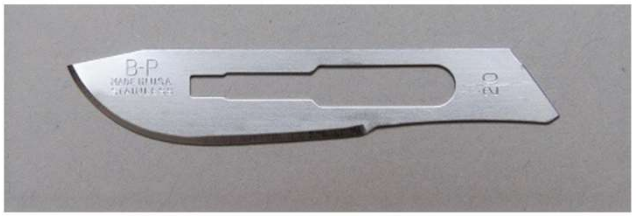
An atom of carbon only has six protons, six electrons, and six neutrons and is much smaller than an iron atom.

Carbon atoms are much smaller than iron atoms. When added together, carbon arranges itself between the iron. The carbon atoms prevent the iron atoms from easily sliding over one another. In this way, the content and distribution of carbon helps to determine the hardness and strength of a steel. In addition to carbon, most steel has a number of other elements mixed in. Each different element causes specific changes in that steel’s molecular structure. By knowing the mixture of elements used to create a specific steel, you can predict how it will perform.

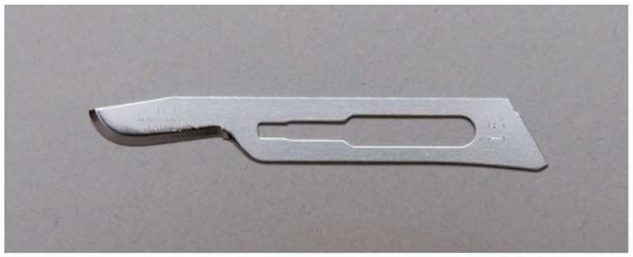
MACROSTRUCTURE OF SURGICAL BLADES

#10 – A large curved cutting edge, which represents a more traditional blade shape. It is used for cutting soft tissue, typically with large incisions.

#11 – A long, triangular blade with the hypotenuse as its sharpest edge. Because of its pointed tip, it is typically used for stabbing incisions and/or short, precise cuts that are shallow.



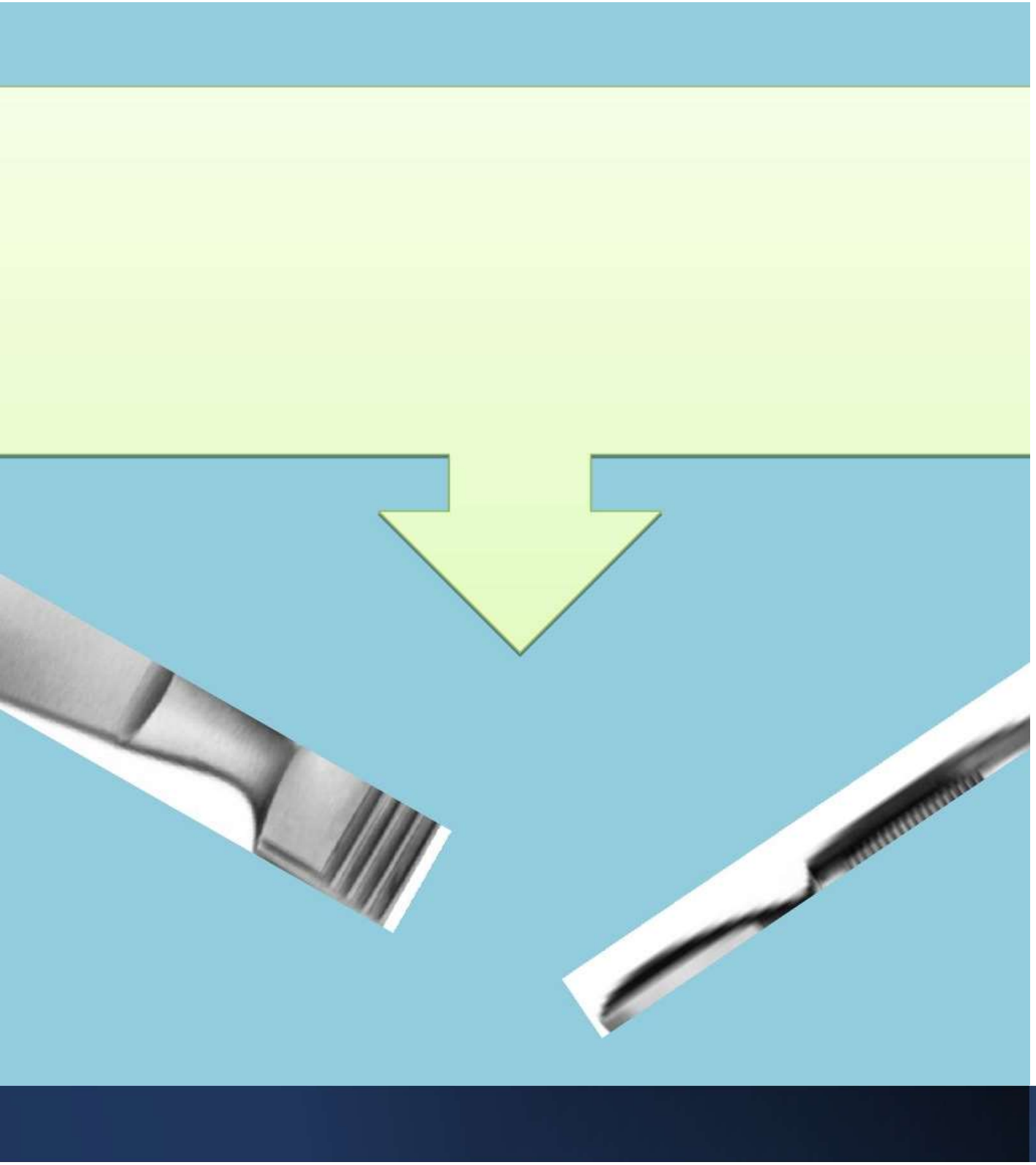
#12 – A small, pointed, crescent-shaped blade used typically as a suture cutter. It is most sharp on the inside edge of its curve.



#15 – Ideal for making short, precise incisions because of its small, curved cutting edge.

#20 - A large curved blade commonly used for cutting tissue and other procedures that require a puncture or cut.

#21 –Similar to the #20, it features a large curved blade commonly used for cutting tissue and other procedures that require a puncture or cut.



Two Kind

- Scalpel is a surgical knife there are 2 kinds, namely: a. Pointed (pointed tip, sharp) b. Bellied (convex)

Catalog Number	Size	Length (in.)
BB074R	#3	5
BB075R	#3L	8 1/4
BB175R	#3XL	9 3/4
MB917R	#3	16

CORWIN Knife Handle

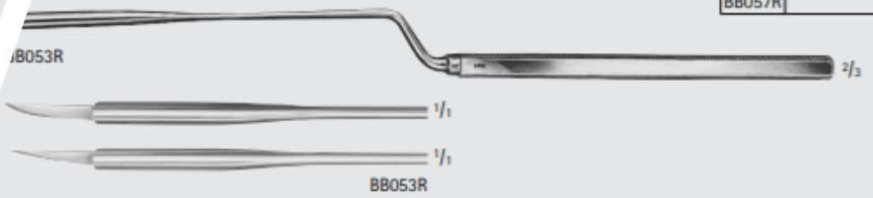
Catalog Number	Length (in.)
MA203R	5 1/2

CASPAR Scalpel Handle

Catalog Number	Length (in.)
BB052R	7

LANDOLT Scalpel Handle, F/ Microsurgery Blades

Catalog Number	Length (in.)
BB053R	8 1/4
BB057R	9 3/4



LISTON Amputating Knife

Catalog Number	Blade Length (mm)	Blad
FH100R	130	
FH101R	160	
FH102R	190	
FH103R	220	

CATLIN Amputating Knife, Double Cutting

Catalog Number	Blade Length (mm)	Blade Size (in.)
FH116R	160	6 1/4

Measurement Shape Size and Handle

Product

- Demotek-Surgical Blades.
- Sterile Disposable Blades.
- Standard Surgical Blades.
- Carbon Steel Blades.
- Surgical Blades.
- Disposable Surgical Blades.
- Sterile Stainless Steel Surgical Blades.
- Disposable Sterile Surgical Blades.
- Sterile Surgical Blades.

Process

- Edge Finishing Surgical Blades using the FARADAYIC Process.

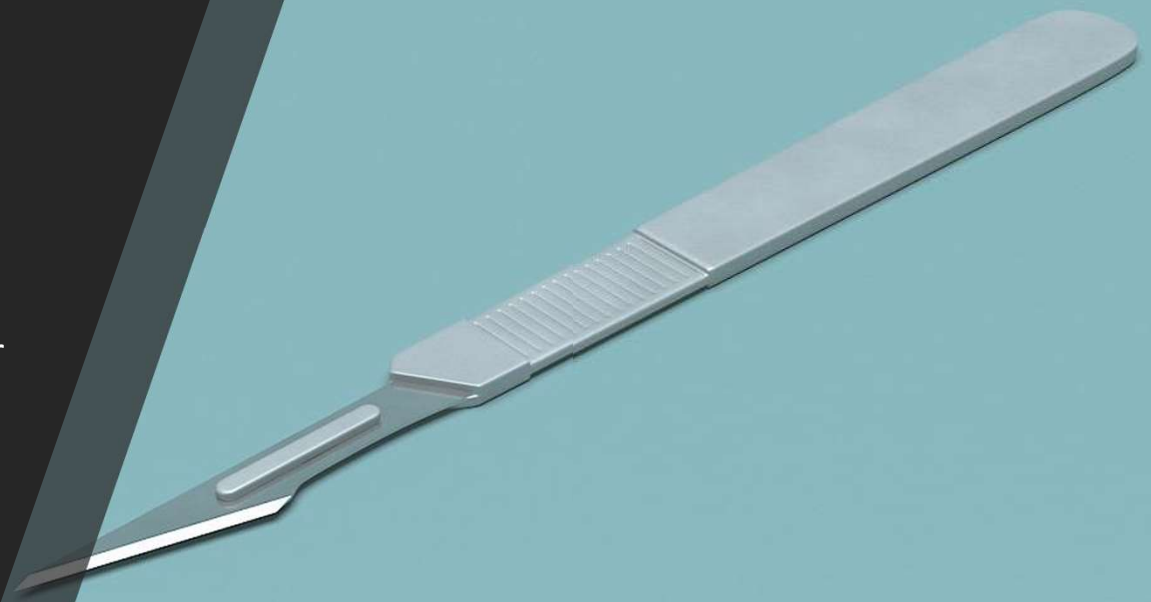
Raw Materials

Stainless Steel.

Carbon Steel.

Processing

- Press
- Stainless Steel
- Carbon Steel
- Thermal process
- Heat treatment
- Blade edging(NC)
- Abrasion of Blade
- Polishing special blade
- Magnetizing
- Anti-corrosive chemical
- Assembly/ Inspection / Packing
- Cobalt radiation Chamber
- Sterilizing process
- To use one time
- Completion



How Surgical/Scalpel Blades are Made

- The Scalpel is the surgeons trademark tool. Its short blade is **razor sharp** and designed to slice swiftly and cleanly through skin and what lies **underneath**. The Surgical knife maybe simple instrument but using it requires years of intensive training and steady hands capable of great precision. They make **scalpel handless** from rods of **stainless steel** the **blade are made** either of **carbon steel or stainless steel**.

- They are **sterile** and for one time use only. The blade steel is extremely thinness than point **4mm.** It arrives at the scalpel factory in **coiled strips** the first machine feeds the strips into a press. A die inside punches out unfinished blade called **Blacks**. Blades vary in **size** and **contour**, but they all have the same slot in the center for attaching the handle, when you **flex** a blank it bends entirely out-of-shapes, so the next step is to **temper the steel.** The blanks pass through a furnace for about **30 seconds**. The **heat alters the molecular structure** of the metal hardening it, now the blank has the flexibility a scalpel blade requires. From the furnace they moves through a **punching tool** that **pops** them from the **strip**. The separated blanks stack on a peg.

- Heat Treatment

- A worker now takes each stack threads a metal ring through the slots to keep them together then spends off the blanks for surface polishing that will restore the metals origin sheen which the **heat treatment dulled**. After polishing workers visually inspect every blank discarding any defective ones. They transfer the blanks from the **ring to a metal road** using a **gauge** to measure out the right number.

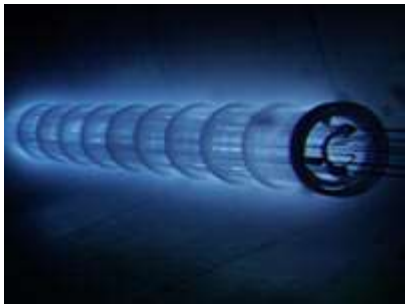
- Blades cling together

- From here they mount the roads onto grinding machines each one picks up a **blank with a magnet** then places it in a holder. The holder runs the blank against a **wheel coated in diamond particles** a **powerful abrasive** that smoothly wears down steel. The wheel shapes and sharpness a cutting angle transforming a blank into a blade.

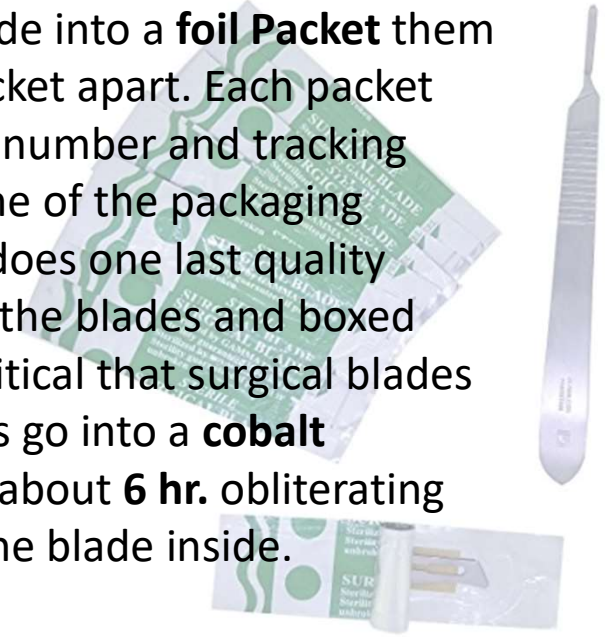
- As the blade comes off the grinder they **cling together** because the **magnet** that fed them into the machine **magnetized them**. To cancel this effect a demagnetizing machine passes on electromagnet behind the stacks of blades. After a thorough cleaning in ultrasonic cleaning tanks.

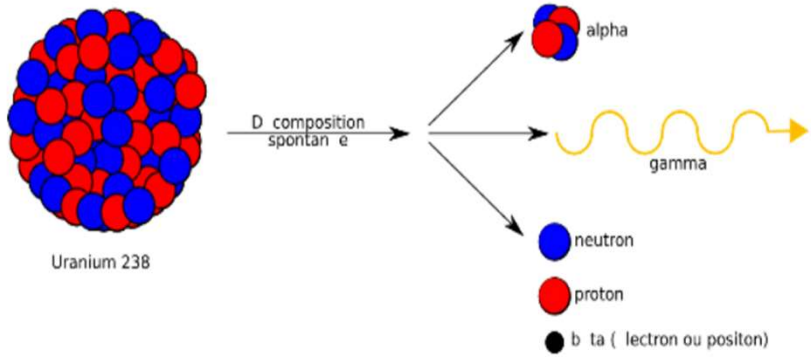
The blades move on to final inspection, workers **wear rubber cover to protect their fingers** and keep the blade clean. They scrutinize the cutting edge discarding and blade that's less than perfect. Each and every blade passes through two different inspectors.

Anti Corrosion chemical



- In the packaging department the first machine covers each blades with **a brown paper strip** that contains and **anti-corrosion chemical**. This provides extra protection against rust. The next machine Slips each Blade into a **foil Packet** them cuts the connected packet apart. Each packet bears the blade model number and tracking code. As the blade come of the packaging machine an inspector does one last quality check. Then he counts the blades and boxed them. Of course, it's critical that surgical blades be sterile, so the boxes go into a **cobalt radiation chamber** for about **6 hr.** obliterating any contaminates on the blade inside.





Gamma radiation is created by the decomposition of an atom

- When the boxes exit the chamber their hospital ready. In the operating room it's simply a matter of sliding the blade onto the protruding part of the handle called the bayonet. Like blade scalpel handles also come in different shapes and size. Surgeons optimize their **dexterity** by choosing the handle that's the best fit for their hands and the best suited for the procedure those hands are performing.

Safety Measures

Operating Procedure for use of Surgical Blades.

Safe and quick way to remove surgical blades.

Surgical Blades-Safety designed for operating room.

Machinery

Automatic Surgical Blade Grinding Machine.

Surgical Blade Packaging Machine.

Information @ a Glance

•A scalpel is a small but extremely sharp knife used for surgery, anatomical dissection, and various arts and crafts.
•Scalpels may be disposable or re-usable.
•Scalpel blades are usually of hardened and tempered steel.
•Surgical scalpels consist of two parts, a blade and a handle.
•A laser scalpel is a scalpel for surgery, cutting or ablating living biological tissue by the energy of laser light.
•The Futura Safety Scalpel is the only safety scalpel currently on the market that employs automated retraction.
New diode-pumped solid-state lasers doped with thulium can be wavelength-tuned around the local water absorption peak at 1.94μm, making them attractive as versatile laser scalpels. A fine layer of a ceramic material based on titanium oxide that groups together bactericidal and anti-microbe properties on the surface of medical and dental instruments such as scalpels, pincers and drills for creating a nanostructured material that is self-sterilizing.
Two broad approaches developed by manufacturers to improve scalpel safety 1. Safety Scalpels. 2. Combination of single handed scalpel blade remover with a passing tray

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Patent

•Disposable Safety Surgical Blade.
•Method of Manufacture of Surgical Blades.
•Handle with Removable Disposable Surgical Blade.
•Disposable Sterile Surgical Adaptor.
•Coated Surgical Blade.
•Surgical Blade Remover.
•Surgical Blade for use with a surgical tool.
•Disposable Surgical Blade Holder.
•Surgical Blade Dispenser.