

# **ELECTRICAL DISCHARGE MACHINING**

**MATERIALS SCIENCE AND  
TECHNOLOGY II PRESENTATION**

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# WHAT IS EDM?

- ❑ Electrical Discharge Machining
- ❑ Used on hard metals
- ❑ works with electrically conductive materials



# HISTORY OF EDM

- In 1770s, discovered by Joseph Priestly.
- Developed in the mid 1970s
- In the mid 1980s, the EDM techniques were transferred to a machine tool
- Today, it is a viable technique that helped shape the metal working industry.



# ACCESSORIES

- surface plate
- surface gage
- sine plate
- gage block set
- pin gage set
- dial indicator
- drop indicators
- precision vise
- tooling ball set
- and various electrode holders



# BASIC DEFINITIONS

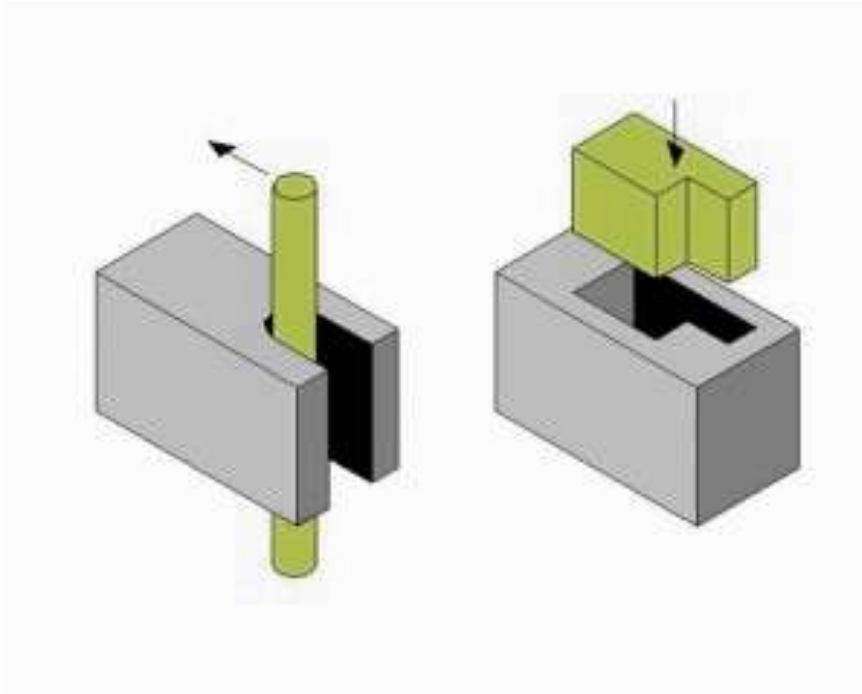
- Workpiece
- Sparks
- Electrodes
- Dielectric liquid
  - Deionized water
  - Dielectric oil
- Cutting speed
- Accuracy



# TYPES OF EDM

○ Wire Machining

○ Ram Machining



## Other EDM Processes

Electrical Discharge Milling

Electrical Discharge Grinding

Electrical Discharge Dressing

Ultrasonic Aided EDM

Abrasive Electrical Discharge  
Grinding

Micro Electrical Discharge  
Machining

Micro Wire EDM

Mole EDM

Double Rotating Electrodes EDM

# WHEN TO USE EDM

- Where deep cutting is required
- In unattended cutting
- For high-expertise parts
- Where EDM finish is specified

- For hard materials
- For sharp inside corners
- For the most complex geometry



# How EDM WORKS?

- Uses very powerful sparks ( $\sim 3 \times 10^6$  V/m)
  - Series of rapidly recurring charges
- ↓
- electroerosion
- ↓
- Remove excess by fluid flow





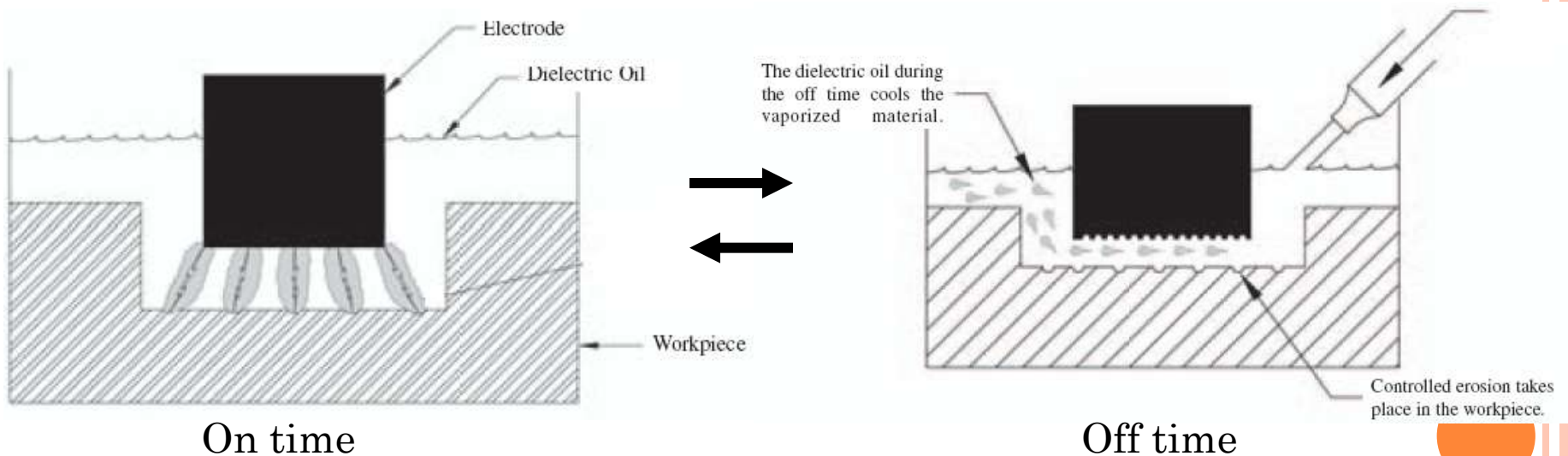
# SPARKS

- The phenomena “Breakdown” occurs
- A path for the current through dielectric
- Locally 10-15.000 °C
- Ionize the fluid
- Metal melts or vaporizes



# PULSING SPARKS

- Periodically striking ( $>100.000$  sparks/sec)
- More accurate machining
- Controlling the on-off time for optimization

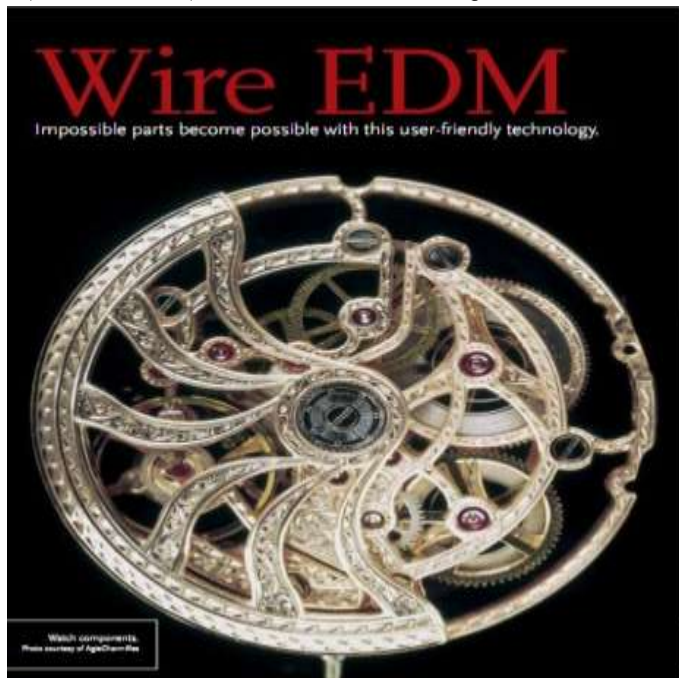


# MOVING THE TOOL

- CNC control (computer numerical controlled)
- Enable 3D movement
- Not necessary in all types
- Very important in wire EDM



- Wire EDM for detailed shapes
- Sinker EDM for dies (mold) industry

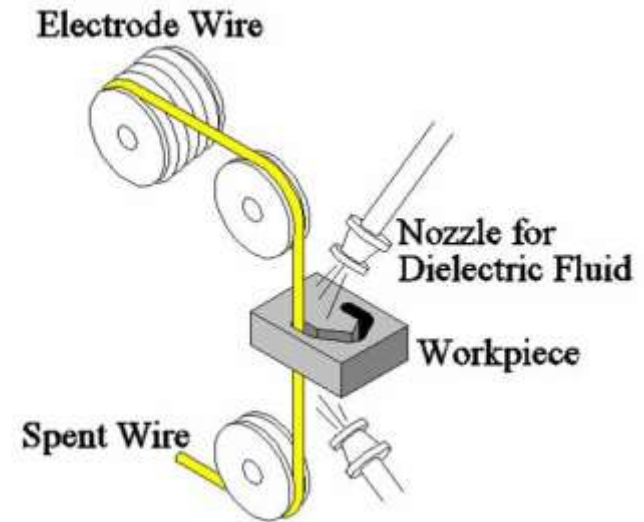


<http://www.todaysmachiningworld.com/wp-content/uploads/2010/10/hiwwire-465x600.jpg>

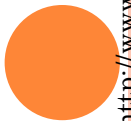
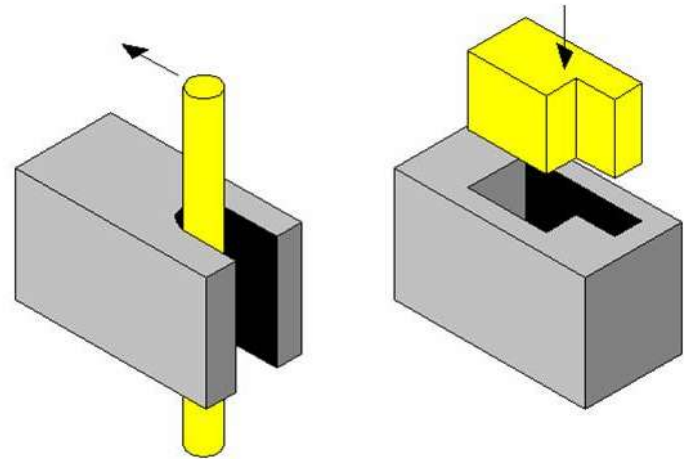


# WIRE EDM

- ❑ Needs wire feed
- ❑ Can work overnight
- ❑ Impossible to have narrower gap than the wire
- ❑ Can be close to wire diameter



- Voltage changes with distance
- Distance must be controlled
- Manufacturer programs do all the work
- Promising method with oscilloscope



# TOOL EROSION (WEAR)

- Tool is also eroded
- It can be replaced (wire feed)
- Affects the shape of workpiece
- Can be proceed with negative-piece
- Reverse polarity electoplatinig
- Deposits the eroded graphite back





**EDM** IS A MACHINING *METHOD*  
*TYPICALLY USED* FOR HARD METALS  
WHICH ARE ELECTRICALLY CONDUCTIVE.

**IT** MAKES POSSIBLE TO WORK WITH  
METALS FOR WHICH TRADITIONAL  
MACHINING TECHNIQUES ARE  
INEFFECTIVE.



- EDM can be used to make fixtures, collets and jet engine blade slots, mold cooling ribs and reinforcing ribs. This fact makes wire and ram EDMs ideal for making magnetic reader heads for missiles, artificial joints, turbine blades and car engine prototypes (bgpeck)



**Engine Turbine Blades**



# APPLICATIONS

- **Prototype production**

The EDM process is most widely used by the mould-making tool and die industries, but is becoming a common method of making prototype and production parts, especially in the aerospace, automobile and electronics industries in which production quantities are relatively low.

- **Metal disintegration machining**

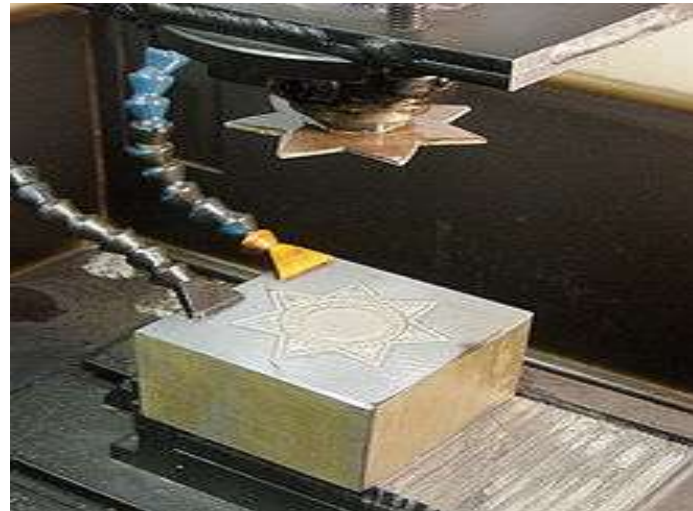
Several manufacturers produce EDM machines for the specific purpose of removing broken tools (drill bits or taps) from work pieces. In this application, the process is termed "metal disintegration machining".



# COINAGE DIE MAKING

This type of EDM is usually performed submerged in an oil-based dielectric. The finished object may be further refined by hard (glass) or soft (paint) enameling and/or electroplated with pure gold or nickel. Softer materials such as silver may be hand engraved as a refinement.

Master at top, badge die workpiece at bottom, oil jets at left (oil has been drained). Initial flat stamping will be "dapped" to give a curved surface.



- **Small hole drilling**

On wire-cut EDM machines, small hole drilling EDM is used to make a through hole in a workpiece in through which to thread the wire for the wire-cut EDM operation. A separate EDM head specifically for small hole drilling is mounted on a wire-cut machine and allows large hardened plates to have finished parts eroded from them as needed and without pre-drilling.



A blade with internal cooling as applied in the high-pressure turbine



# EXAMPLES OF USE

- Slots, keyways, square & hex drives
- Gears, splines
- Small or deep holes, especially in hardened
- Removal of broken taps and drills
- Hard tapping
- Machining of carbide
- Application of textured surface finish



# EXAMPLE APPLICATIONS OF WIRE EDM



**Miniature Parts**

**0.002 Diameter Wire — Internal Gear**





## Titanium Needles

**Example of Stacking Work Pieces**



# EXAMPLE APPLICATIONS OF WIRE EDM



**Precision Die Matching**

**7min(Ra) surface finish  
without isolated tooling**





# ADVANTAGES AND DISADVANTAGES

- EDM is a method of machining parts that cannot be done by conventional machines.
- “Since the tool does not touch the workpiece, there are no cutting forces generated; therefore, very fragile parts can be machined” .
- The shape and also the hardness of the materials being used make EDM ideal.



## SOME OF THE ADVANTAGES OF EDM INCLUDE MACHINING OF:

- Complex shapes that would otherwise be difficult to produce with conventional cutting tools
- Extremely hard material to very close tolerances
- Very small work pieces where conventional cutting tools may damage the part from excess cutting tool pressure.



# SOME OF THE ADVANTAGES OF EDM INCLUDE MACHINING OF:

- Intricate & complex details are possible
- Internal corners down to R .001" [.025mm]
- Small features down to .004" [.10mm]
- Very high accuracy attainable
- Precise control of surface finish
- No cutting forces
- Virtually no geometric limitations



# SOME OF THE DISADVANTAGES OF EDM INCLUDE:

- The slow rate of material removal.
- The additional time and cost used for creating electrodes for ram/sinker EDM.
- Specific power consumption is very high.
- Power consumption is high.



# ADVANTAGES AND DISADVANTAGES OF EDM VERSUS TRADITIONAL MACHINING

## Advantages

- handles delicate tasks
- may cut or drill very hard materials
- highly accurate
- very small kerf for wire EDM
- produces complex, deep, or 3-D shapes
- no burrs

## Disadvantages

- electrode wear
- slow cutting rates
- thin, brittle heat-affected zone



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