MUZAFFARPUR INSTITUTE OF TECHNOLOGY

COURSE FILE

OF

NON CONVENTIONAL MANUFACTURING

(021617)

Faculty Name: Mr. SANTOSH KUMAR

ASSISTANT PROFESSOR,

DEPARTMENT OF MECHANICAL ENGINEERING

विज्ञान एवं प्रावैधिकी विभाग

Department of Science and Technology

Government of Bihar

CONTENTS

Department of Mechanical Engineering

Vision

- To strengthen the region through imparting superior quality technical education and research; which enables the fulfillment of industrial challenge and establish itself as a Centre of Excellence in the field of Mechanical Engineering.

Mission

- To build an academic environment of teaching and lifelong learning for students to make them competitive in context with advance technological, economical and ecological changes.
- To enable the students to enhance their technical skills and communications through research, innovation and consultancy projects.
- To share and explore the accomplishments through didactic, enlightenment, R & D programs with technical institution in India and abroad.

Mechanical Engineering Program Educational Objectives

After 4 year of graduation a B.TECH (ME) graduate would be able to

- Graduates will spread and enhance their technical capability and proficiency through vital domain of economical, environmental and social concerns affiliated with the mankind and industry.

- Graduates will able to work professionally with modern methods in the area of Thermal, Mechanical System Design, Manufacturing, Measurement, Quality control and other interdisciplinary fields of concerns.

- Graduates will practice Mechanical engineering in sensible, flexible and ethical manner to benefit the society, industry and nation toward the rapidly changing global technical standards.

- Graduates will serve as ambassadors for engineering by their knowledge, creativity, imagination and innovation and set new extremes in their profession through lifelong learning.

Mechanical Engineering Student Outcomes

Students who complete the B.TECH degree in ME will be able to:

1. An ability to apply the knowledge of mathematics, basic sciences and engineering concepts to solve the complex engineering problems.
2. The ability to conduct experiments and to critically analyze and interpret the experimental data to reach at substantial outcomes.
3. An ability to design systems, components, or processes to meet appropriate needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. An ability to identify, formulates, and solves the complex engineering problems.
5. An ability to function on multi-disciplinary teams that leads the multi-disciplinary projects.
6. An understanding of professional and ethical responsibility.

7. An ability to communicate effectively with written, oral, and visual means.
8. An ability to understand the impact of engineering solutions in a global, environmental, economical and societal context.
9. An ability to recognize the need to engage in life-long learning.
10. An ability to attain knowledge of contemporary issues.
11. An ability to use the techniques, skills, and modern tools necessary for Mechanical engineering practice.
12. Possess ability to estimate costs, estimate quantities and evaluate materials for design and manufacturing purposes.

Course Description

This course is designed to understand advance manufacturing process within the Mechanical Engineering curriculum. Students will explore advance manufacturing process over conventional manufacturing process known as non-conventional manufacturing. The non-conventional manufacturing is designed to prepare interested students for future careers manufacturing industry where non-conventional machines are used.

Course Objectives

1. Understand conventional and non-conventional manufacturing term.
2. Learn different types of unconventional machining process and advance machines.
3. Learn different types of unconventional joining process and advance joining machines.
4. Learn different types of unconventional forming process.

Course Outcomes

ME-021x17.1 Students will able to implement the mechanical energy, chemical and electrochemical based unconventional machining process.

ME-021x17.2 Students will able to implement explosive energy and high energy beam to welding process.

ME-021x17.3 Students will able to implement water energy, electro-magnetic, electro-discharge and explosive energy for forming process.

ME-021x17.4 Students will able to model mathematically and analyse various unconventional machining process.

ME-021x17.5 Students will able to recognize the need of industries' current necessity and environment related issue.

CO-PO MAPPING

Sr. No.	Course Outcome	PO
1.	ME-021x17.1 Students will able to implement the mechanical energy, chemical and electrochemical based unconventional machining process.	PO1, PO6, PO8, PO9
2.	ME-021x17.2 Students will able to implement explosive energy and high energy beam to welding process.	PO1, PO2, PO3, PO5
3.	ME-021x17.3 Students will able to implement water energy, electro-magnetic, electro-discharge and explosive energy for forming process.	PO1, PO2, PO4, PO12
4.	ME-021x17.4 Students will able to model mathematically and analyse various unconventional machining process.	PO1, PO3, PO10
5.	ME-021x17.5 Students will able to recognize the need of industries' current necessity and environment related issue.	PO5, PO7, PO11,PO12

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ME-021x17.1 Students will able to implement the mechanical energy, chemical and electrochemical based unconventional machining process.	√					√		√	√			
ME-021x17.2 Students will able to implement explosive energy and high energy beam to welding process.	√	√	√		√							
ME-021x17.3 Students will able to implement water energy, electro-magnetic, electro-discharge and explosive energy for forming process.	√	√		√								√
ME-021x17.4 Students will able to model mathematically and analyse various unconventional machining process.	√		√							√		
ME-021x17.5 Students will able to recognize the need of industries' current necessity and environment related issue.					√		√				√	√

B. Tech. VI Semester (Mechanical)
ME-021x17 NON CONVENTIONAL MANUFACTURING

L T P/D	Total			
3-1-0	4	Max Marks:	100	
			Final Exam:	70 Marks
			Sessional:	20 Marks
			Internals:	10 Marks.

UNIT-I

Introduction: Limitation of conventional manufacturing processes, need of unconventional manufacturing process and its classification.

UNIT-II

Unconventional machining process: Principle and working and applications of unconventional machining process such as electro–discharge machining, electrochemical machining, ultrasonic machining, abrasive jet machining etc.

UNIT-III

Unconventional welding process: Principle and working and applications of unconventional welding processes such as laser beam welding, electron beam welding, ultrasonic welding, plasma arc welding.

UNIT-IV

Explosive welding, cladding etc. under water welding, metallising.

UNIT-V

Unconventional forming processes, principle, working and applications of high energy forming processes such as explosive forming, electromagnetic forming, electro-discharge forming, water hammer forming, explosive compaction etc.

Books:

1. Manufacturing Technology by P.N.Rao
2. Production Technology by R.K.Jain
3. Advanced Machining Process by V.K. Jain

GATE SYLLABUS

NON CONVENTIONAL MANUFACTURING

Section 4: Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; **principles of non-traditional machining processes**; principles of work holding, design of jigs and fixtures.

6th Semester ME								ROOM NO-47
Day/ time	**10:00-10:50**	**10:50-11:40**	**11:40-12:30**	**12:30-13:20**	**13:20-13:50**	**13:50-14:40**	**14:40-15:30**	**15:30-16:20**
MON	**HMT AK**	**CMS NK**	**NCM SK**	**INS & MSR NKD**	**BREAK**	**SEMINAR**		**GATE CLASS**
TUE	**INS & MSR NKD**	**IE&A IH**	**NCM SK**	**DME SG**			**NCM SK**	**GATE CLASS**
WED	**NCM SK**	**CMS NK**	**IE&A IH**	**HMT AK**		**M1 DME LAB (SG+RKR)/M2 CMS (HKC)**		
THU	**INS & MSR NKD**	**IE&A IH**	**CMS NK**	**DME SG**		**M2 DME LAB (SG+RKR)/M1 CMS (HKC)**		
FRI	**HMT AK**	**DME SG**	**INS & MSR NKD**			**M1 HMT LAB (GK)**		
SAT		**IE&A IH**	**GATE CLASS**			**M2 HMT LAB (GK)**		

MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR
6th SEMESTER

Branch	Name	Roll. No.
MECHANICAL ENGINEERING	ASHISH CHAURASIA	15M01
	RAJ KAMAL	15M02
	VIVEK KUMAR	15M03
	RAM BHADRA JHA	15M04
	RITU RAJ	15M05
	SUMIT KUMAR	15M06
	PAWAN KUMAR PIYUSH	15M07
	HIMANSHU KUMAR	15M08
	ANMOL	15M09
	MADHU PRIYA	15M10
	SANJAN KUMAR YADAV	15M11
	PRAVEEN KUMAR	15M12
	VIKASH KUMAR KESHRI	15M13
	AHSAN SOHAIL	15M14
	MUKESH KUMAR ROY	15M15
	SAJAN KUMAR	15M16
	SUMAN KUMAR SINHA	15M17
	RITESH KUMAR	15M18
	SHANUR RAHMAN WAHID	15M19
	MD AFTAB ALAM	15M20
	DHEERAJ KUMAR	15M21
	SAROJ KUMAR PASWAN	15M23
	MAYANK	15M24
	ASHOK DAS	15M25
	ALOKRAJ	15M26
	ASHIWANI KUMAR	15M28
	NEHAL ANSARI	15M29
	DHARMENDRA KUMAR	15M30
	ASHVANI KUMAR	15M31
	DHANANJAY KUMAR	15M32
	RAHUL KUMAR	15M33
	RANJAN KUMAR	15M34
	ANURAG KUMAR RAVI	15M35
	RAVI RAJ	15M36
	ANKIT AKASH	15M37
	PRAMENDRA KUMAR	15M38
	RAMESH KUMAR	15M39
	GANGA RAM MANDAL	15M40
	ROHIT KUMAR	15M41
	UJJWAL KASHYAP	15M42
	NISHANT KIRAN	15M44

	AMAN KUMAR JHA	15M46
	NITISH KUMAR	15M47
	NAVEEN KUMAR	15M48
	DHANANJAY KUMAR CHOUDHARY	15M49
	AAKASH KUMAR	15M50
	DEEPAK KUMAR	15M51
	SURANJAN KUMAR	15M52
MECHANICAL ENGINEERING	MONU KUMAR	15M53
	SANJEEV KUMAR ADITYA	15M54
	ISHA SHARMA	15M55
	NEETU GUPTA	15M56
	AMIT KUMAR	15M57
	MERAJ AHMED	15M58
	MANISH KUMAR SINGH	15M59
	ABHINANDAN KUMAR	15M60
	RAM KUMAR MAHTO	15M61
	ROHIT RAJ	15M62
	VIKAS KUMAR SAXENA	15M63
	SUMIT KUMAR	15M64
	PRAKASH KUMAR	15M65
	ANAND MOHAN DEO	15M66
	ADITYA KUMAR	15M67
	ADITYA KUMAR	16(LE)M01
	SHAKTI KUMAR	16(LE)M02
	ROHIT KUMAR	16(LE)M03
	KUMARI PRIYA RANJAN	16(LE)M04
	KAMLESH KUMAR	16(LE)M05
	KUMAR PRATIK VISHWAS	16(LE)M06
	VIKRANT KUMAR	16(LE)M07
	NIRBHAY KUMAR	16(LE)M08
	RAUSHAN KUMAR SINGH	16(LE)M09
	HIMANSHU CHANDRA	16(LE)M10

Institute / College Name :	MUZAFFARPUR INSTITUTE OF TECHNOLOGY
Program Name	B.TECH MECHANICAL
Course Code	021617
Course Name	NON CONVENTIONAL MANUFACTURING
Lecture / Tutorial (per week):	3/1	**Course Credits**	4
Course Coordinator Name	MR. SANTOSH KUMAR

1. Scope and Objectives of the Course

The goal of this course is to provide the motivations, definitions and techniques for the analysis of advanced and non-conventional manufacturing processes applied to machining of traditional and innovative materials, such as composite materials. On successful completion of this module, the student should understand the fundamental concepts of non-conventional manufacturing technologies and the differences with the conventional processes.

The course outcomes are:

1. Students will able to implement the mechanical energy, chemical and electrochemical based unconventional machining process.
2. Students will able to implement explosive energy and high energy beam to welding process.
3. Students will able to implement water energy, electro-magnetic, electro-discharge and explosive energy for forming process.
4. Students will able to model mathematically and analyse various unconventional machining process.
5. Students will able to recognize the need of industries' current necessity and environment related issue.

2. Textbooks

TB1: 'Manufacturing Technology' by P.N. Rao,

TB2: 'Production Technology' by R.K. Jain,

3. Reference Books

RB1: 'Manufacturing Engineering and Technology' by Serope Kalpakjian,

Other readings and relevant websites

S.No.	**Link of Journals, Magazines, websites and Research Papers**
1.	https://www.sciencedirect.com/science/article/pii/S0924013604001669
2.	https://patents.google.com/patent/US4545874A/en
3.	https://www.sciencedirect.com/science/article/pii/S0890695507002325
4.	https://link.springer.com/referenceworkentry/10.1007%2F978-3-642-20617-7_6480
5.	https://www.sciencedirect.com/science/article/pii/S0921509399006620
6.	https://www.sciencedirect.com/science/article/pii/S0924013607008709
7.	https://www.degruyter.com/downloadpdf/j/adms.2008.8.issue-3/v10077-008-0040-3/v10077-008-0040-3.pdf
8.	https://patents.google.com/patent/US4187709A/en

9. Course Plan

Lecture Number	**Date of Lecture**	**Topics**	**Web Links for video lectures**	**Text Book / Reference Book / Other reading material**	**Page numbers of Text Book(s)**
1-2		**Introduction**		TB2, RB1, TB1	342-343, 764, 324-325
		Limitation of conventional manufacturing process, need of unconventional manufacturing process and its classification	https://www.youtube.com/watch?v=cxU1zUOpGLk	http://nptel.ac.in/courses/1121070 77/1	
Tutorial - 1					
3-4		**Electro discharge machining**		TB2, RB1, TB1	
		Principle, working, advantages, disadvantages and applications of electro discharge machining	https://www.youtube.com/watch?v=rA09KaPL7_8	http://nptel.ac.in/courses/112107077/23	343-350, 774-777, 326-345

5-6		**Electrochemical machining**		TB2, RB1, TB1	351-355, 770-773, 346-354
		Principle, working, advantages, disadvantages and applications of electrochemical machining	https://www.youtube.com/watch?v=fOc65syJvDM	http://nptel.ac.in/courses/112107077/28	
Tutorial - 2					
7-8		**Ultrasonic machining process**		TB2, RB1, TB1	367-370, 750-751, 355-357
		Principle, working, advantages, disadvantages and applications of ultrasonic machining process	https://www.youtube.com/watch?v=XXm4Cf_N9CA	http://nptel.ac.in/courses/112107077/21	
9-10		**Abrasive jet machining**		TB2, RB1, TB1	365-366, 783-784, 364-369
		Principle, working, advantages, disadvantages and applications of abrasive jet machining process	https://www.youtube.com/watch?v=FYOsuqdD274	http://nptel.ac.in/courses/112107077/17	
Tutorial - 3					
Mid-Semester Exam (Syllabus covered from 1-16 lectures)					
11-12		**LASER beam machining**		TB2, RB1, TB1	360-364, 778-779, 361-363
		Principle, working, advantages, disadvantages and applications of LASER beam machining process	https://www.youtube.com/watch?v=mgaukC25Hqk	http://nptel.ac.in/courses/112107077/26	
13-14		**Electron beam machining**		TB2, RB1, TB1	379, 781, 370-371
		Principle, working, advantages, disadvantages and applications of LASER beam machining process	https://www.youtube.com/watch?v=pkikv0RHWTA	http://nptel.ac.in/courses/112105127/pdf/LM-40.pdf	
Tutorial - 4					
15-17		**LASER beam welding**		TB2, RB1	312, 811-812
		Principle, working, advantages, disadvantages and applications of LASER beam welding process	https://www.youtube.com/watch?v=Xv55EYGIUn4	http://nptel.ac.in/courses/112107077/36	
18-20		**Electron beam welding**		TB2, RB1	310-311, 810
		Principle, working, advantages, disadvantages and applications of Electron beam welding process	https://www.youtube.com/watch?v=Fr0oFSX8Uwg	http://nptel.ac.in/courses/112107077/35	
Tutorial - 5					
21-23		**Ultrasonic welding**		TB2, RB1	310, 820
		Principle, working, advantages, disadvantages and applications of Ultrasonic welding process	https://www.youtube.com/watch?v=1TBKSGwHTgI	http://nptel.ac.in/courses/112107077/33	
24-26		**Plasma arc welding**		TB2	309
		Principle, working, advantages, disadvantages and applications of Plasma arc welding process	https://www.youtube.com/watch?v=Fr0oFSX8Uwg	http://nptel.ac.in/courses/112107077/35	
Tutorial - 6					

27-28		**Explosive welding**		TB2, RB1	312, 832
		Principle, working, advantages, disadvantages and applications of explosive welding and cladding process	https://www.youtube.com/watch?v=ykf2Zckqcl4	http://nptel.ac.in/courses/112107077/module4/lecture3/lecture3.pdf	
29-30		**Under water welding**		TB2, RB1	308, 819
		Principle, working, advantages, disadvantages and applications of Under-water welding and metallizing process		https://www.fsb.unizg.hr/usb_frontend/files/1465217921-0-underwaterweldingandcuttinggaraikouh_rev2.pdf	
Tutorial - 7					
31-33		**Explosive forming**		RB1	448
		Principle, working, advantages, disadvantages and applications of Explosive forming process	https://www.youtube.com/watch?v=XNG3ewS39Lw	http://nptel.ac.in/courses/112107077/37	
Tutorial - 8					
34-36		**Electromagnetic forming**		TB2, RB1	450, 906
		Principle, working, advantages, disadvantages and applications of Electromagnetic forming process	https://www.youtube.com/watch?v=Ic8Uc41IK1I	http://nptel.ac.in/courses/112107077/37	
Tutorial -9					
37-39		**Electro-discharge forming**		TB2, RB1	452, 907
		Principle, working, advantages, disadvantages and applications of Electro-discharge forming process	https://www.youtube.com/watch?v=Ic8Uc41IK1I	http://nptel.ac.in/courses/112107077/37	
Tutorial - 10					
40-42		**Water hammer forming & explosion compaction**		TB2, RB1	453, 908-910
		Principle, working, advantages, disadvantages and applications of Water hammer forming and Explosive compaction process	https://www.youtube.com/watch?v=XNG3ewS39Lw	http://nptel.ac.in/courses/112107077/37	

1. **Evaluation Scheme:**

Component 1	Mid Semester Exam	20
Component 2	Assignment Evaluation	5
Component 3	TA	5
Component 4**	End Term Examination**	70
	Total	**100**

****** The End Term Comprehensive examination will be held at the end of semester. The mandatory requirement of 75% attendance in all theory classes is to be met for being eligible to appear in this component.

SYLLABUS

Topics	No of lectures	Weightage
Introduction : Limitation of conventional manufacturing processes, need of unconventional manufacturing process and its classification	2	10%
Unconventional machining process : Principle and working and applications of unconventional machining process such as electro – discharge machining, electrochemical machining, ultrasonic machining, abrasive jet machining etc.	12	25%
Unconventional welding process : Principle and working and applications of unconventional welding processes such as laser beam welding, electron beam welding, ultrasonic welding, plasma arc welding.	12	25%
Explosive welding, cladding etc. under water welding, metallizing.	4	15%
Unconventional forming processes, principle, working and applications of	12	25%

high energy forming processes such as explosive forming, electromagnetic forming, electro-discharge forming, water hammer forming, explosive compaction etc.		

This Document is approved by:

Designation	Name	Signature
Course Coordinator	Mr. SANTOSH KUMAR	
H.O.D	Dr. VIKASH KUMAR	
Principal	Dr. J. N. JHA	
Date	15/05/2018	

Evaluation and Examination Blue Print:

Internal assessment is done through quiz tests, presentations, assignments and project work. Two sets of question papers are asked from each faculty and out of these two, without the knowledge of faculty, one question paper is chosen for the concerned examination. Examination rules and regulations are uploaded on the student's portal. Evaluation is a very transparent process and the answer sheets of sessional tests, internal assessment assignments are returned back to the students.

The components of evaluations along-with their weightage followed by the University is given below

Sessional Test 1	20%
Assignments/Quiz Tests/Seminars	10%
End term examination	70%

(From amongst the three sessional tests best of two are considered)

Institute / College Name :	MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR, BIHAR		
Program Name	**B.Tech, Mechanical Engineering**		
Course Code	ME 02 1x17		
Course Name	NON CONVENTIONAL MANUFACTURING		
Lecture / Tutorial (per week):	3/1	**Course Credits**	4
Course Coordinator Name	MR. SANTOSH KUMAR		

LECTURE PLAN

Topics	Lecture Number	Date on which the Lecture was taken
Introduction		
Definition ,limitation of conventional manufacturing process	**1**	
Difference between conventional and non-conventional process, need of NCM	**2**	
Classification of NCM, advantages and disadvantages of NCM	**3**	
Unconventional machining process		
Introduction to electro- discharge machining, process,	**4**	
Mathematical modelling, validation	**5**	
Numerical, quiz	**6**	
Introduction to electro- chemical machining, process,	**7**	
Mathematical modelling, validation	**8**	
Numerical, quiz	**9**	
Introduction to ultrasonic machining, process,	**10**	
Mathematical modelling, validation	**11**	
Numerical, quiz	**12**	
Introduction to abrasive jet machining, process,	**13**	
Mathematical modelling, validation	**14**	
Numerical, quiz	**15**	
Unconventional welding process		
Introduction to laser beam welding, process	**16**	
Applications, advantages and disadvantages, quiz	**17**	
Introduction to electron beam welding, process	**18**	
Applications, advantages and disadvantages, quiz	**19**	
Introduction to ultrasonic welding, process	**20**	
Applications, advantages and disadvantages, quiz	**21**	
Introduction to plasma arc welding, process	**22**	
Applications, advantages and disadvantages, quiz	**23**	
Explosive welding		
Introduction to explosive welding, process	**24**	
Applications, advantages and disadvantages, quiz	**25**	
Introduction to cladding, process	**26**	
Applications, advantages and disadvantages, quiz	**27**	
Introduction to under water welding, process	**28**	
Applications, advantages and disadvantages, quiz , metallising	**29**	
Unconventional forming processes		
Introduction to explosive forming, process	**30**	
Applications, advantages and disadvantages, quiz	**31**	
Introduction to electromagnetic forming, process	**32**	
Applications, advantages and disadvantages, quiz	**33**	

Introduction to electro-discharge forming, process	**34**	
Applications, advantages and disadvantages, quiz	**35**	
Introduction to water hammer forming, process	**36**	
Applications, advantages and disadvantages, quiz	**37**	
Introduction to explosive compaction, process	**38**	
Applications, advantages and disadvantages, quiz	**39**	

MUZAFFARPUR INSTITUTE OF TECHNOLOGY

(Established under AICET Act, _____)

Department of Mechanical Engineering
021617 Non Conventional Manufacturing

Assignment I

1. Explain, With a neat sketch, the principal and working of electrochemical machining (ECM) process.
2. Explain briefly, with a neat sketch, the principle and working of ultrasonic machining (USM). List also its advantages, limitation and applications.

3. Write short notes on any two of the following:
   a). Plasma-arc welding
   b). Laser beam welding
   c). Underwater welding
   d). Electro-magnetic forming
4. What is the function of abrasive slurry in ultrasonic machining (USM)? Explain how the abrasive selection is made.
5. a). What are the problems encountered in underwater welding process.
   b). What are the characteristics of gas mixture forming?
6. Explain the following terms of EBM system:
   a). Power supply
   b). Vacuum system and machining chamber

Muzaffarpur Institute of Technology

Department of Mechanical Engineering
Non-Conventional Manufacturing

TUTORIAL SHEET

1. In an ECM operation with the flat surfaces, a 10V D.C. supply is used. The conductivity of the electrolyte is 0.2 ohm^{-1} cm^{-1} and a feed rate of 1 mm/min is used. The work-piece is pure iron. Calculate the equilibrium gap. Consider the total over-voltage to be
   1.5V
   A = 55.85g
   Z = 2
   $\rho = 7.86$ g/cm^3

2. EDM is used to machine a metallic sheet. Calculate surface finish value if C = 15μF, $V_{b\,=}$ 130V, K_6 = 4.0. Use the equation based on experimental results.

3. A Laser beam with a power intensity of $10^5 W/mm^2$ falls on tungsten sheet, Find out the time required for the surface to reach the melting temperature. The given thermal properties of tungsten are melting temperature 3400^{o}c, thermal conductivity 2.15W/cm-^{o}C, volume specific heat 2.71 J/cm^3-^{o}C. Assume that 10% of the beam is absorbed.

MUZAFFARPUR INSTITUTE OF TECHNOLOGY

Under the Govt. of Bihar

MID SEMESTER EXAM-2018 (Summer)

NON-CONVENTIONAL MANUFACTURING (Code: 021617)

SEMESTER – VI (SESSION: 2017-18)

Time: 2 hours ***Full Marks: 20***

Instructions:

(i) *Questions are of equal marks*

(ii) *Answer any four questions*

1.

a) Write down the classification of Non-Conventional Machining process on the basis of energy and explain the need of Non-Conventional manufacturing.

b) What are the difference between Conventional Machining and Non-Conventional Machining?

2. Explain the working principle of electron beam machining (EDM) with neat sketch and also explain the effect of EDM on metal surface.

3. Explain the working principle of electron beam welding with neat sketch. What are the advantages, limitations and applications?

4. Explain the working principle of plasma arc welding with neat sketch and illustrate the advantages and applications.

5. Explain clearly, with a neat sketch, Laser beam machining. State also its advantages, disadvantages and applications.

6.

a) In Electrochemical machining of pure iron a material removal rate of 5 cm^3/min is required. Estimate current requirement. Given
Atomic weight of iron = 56, Valency = 2, Density of Iron = 7.8 gm/cc, Faraday constant = 96500 Coulomb.

b) Electrochemical machining is performed on to remove material from an iron surface of 20mm * 20mm under the following conditions:
Inter electrode gap = 0.2mm, Supply voltage = 12 volt, Specific resistance of electrolyte = 2Ω-cm, Atomic weight of Iron = 55.85, valency of iron = 2, faraday constant = 96540 Coulomb. Find MRR.

Code : 021617

B.Tech 6th Semester Exam., 2014

NONCONVENTIONAL MANUFACTURING

Time : 3 hours

Full Marks : 70

Instructions :

(i) *The marks are indicated in the right-hand margin.*

(ii) *There are* **NINE** *questions in this paper.*

(iii) *Attempt* **FIVE** *questions in all.*

(iv) *Question No. 1 is compulsory.*

(v) *Assuming missing data, if any.*

1. Answer/Choose the most appropriate option of the following (any *seven*) : 2×7=14

   (a) Which of the following processes can be used to produce very small diameter holes?

   (i) Electric discharge machining
   (ii) Electrochemical machining
   (iii) Electron-beam machining
   (iv) Waterjet machining

   (b) Which of the following methods uses a chemical known as etchant during machining?

   (i) Electrochemical machining
   (ii) Electric discharge machining
   (iii) Chemical machining
   (iv) Electron-beam machining

   (c) Ultrasonic machining removes material from the workpiece by

   (i) hammering action of abrasive particles
   (ii) rubbing action between tool and workpiece
   (iii) high-frequency sound waves
   (iv) high-frequency eddy currents

   (d) Vaccum is required in which of the following nonconventional machining methods?

   (i) Laser-beam machining
   (ii) Electron-beam machining
   (iii) Electric discharge machining
   (iv) Electrochemical machining

   (e) Name the dielectric fluid used in EDM.

   (f) Why is a magnetic lens used in electron-beam machining?

   (g) Name three important maskant materials used in chemical machining.

   (h) What is the typical application area of chemical machining?

   (i) What is die sinking?

   (j) For which type of material, ultrasonic machining is useful?

2. (a) Describe the steady state of hole penetration of LBM process. 10

(b) A laser beam with a power intensity of 10^5 W/mm^2 falls on tungsten sheet. Find out the time required for the surface to reach the melting temperature. The given thermal properties of tungsten are melting temperature 3400 °C, thermal conductivity 2·15 W/cm-°C, volume specific heat 2·71 J/cm^3-°C. Assume that 10% of the beam is absorbed. 4

3. (a) Derive one single equation for computing interelectrode gap (IEG) during zero feed rate in ECM process. 10

(b) In an ECM operation with the flat surfaces, a 10 V d.c. supply is used. The conductivity of the electrolyte is $0 \cdot 2\ \text{ohm}^{-1}\ \text{cm}^{-1}$ and a feed rate of 1 mm/min is used. The workpiece is of pure iron. Calculate the equilibrium gap. Consider the total over-voltage to be

1·5 V

$A = 55 \cdot 85$ g

$Z = 2$

$\rho = 7 \cdot 86\ \text{g/cm}^3$ 4

  (Turn Over)

4. (a) Explain the mechanism of explosive welding process. 10

(b) Discuss the plasma arc spraying process. 4

5. (a) Explain the working principle of EBM process. 10

(b) During drilling holes in a steel work-piece by EBM an accelerating voltage of 150 kV is used. Determine the electron range. 4

6. (a) Find the condition for maximum power delivery to the discharging circuit in EDM. 10

(b) EDM is used to machine a metallic sheet. Calculate surface finish value if $C = 15\ \mu F$, $V_b = 130$ V, $K_6 = 4 \cdot 0$. Use the equation based on experimental results. 4

7. (a) What are the problems encountered in underwater welding process? 10

(b) What are the characteristics of gas mixture forming? 4

8. (a) Explain the mechanism of metal removal of PAM. 10

  (Continued)

(b) Explain the following terms of EBM system : 2+2

(i) Power supply

(ii) Vacuum system and machining chamber

9. (a) Discuss the effect of frequency and amplitude of vibration on material removal rate in USM. 10

(b) A drill is required to be made in 5 mm thick tungsten carbide sheet. The slurry is made of 1 part of 320 grit (15 microradius) boron carbide mixed with $1\frac{1}{4}$ parts of water. The static stress is $1\cdot4\ \text{kg}/\text{cm}^2$ and the amplitude of tool oscillation is $0\cdot025$ mm. The machine operates at 25000 circles/sec. The compression fracture strength of WC is $225\ \text{kg}/\text{mm}^2$. Calculate the time required to perform drilling. Assume that only pube out of 10 pulse are effective. 4

★★★

Code : 021617

B.Tech 6th Semester Exam., 2016

NON-CONVENTIONAL MANUFACTURING

Time : 3 hours *Full Marks* : 70

Instructions :

(i) *The marks are indicated in the right-hand margin.*

(ii) *There are* **NINE** *questions in this paper.*

(iii) *Attempt* **FIVE** *questions in all.*

(iv) *Question No.* **1** *is compulsory.*

1. Choose the most appropriate option of the following (any *seven*) : 2×7=14

(a) Ultrasonic machining is based on

(i) uniform heating

(ii) uniform grinding

(iii) vibration waves of high frequency

(iv) uniform machining

(b) In ultrasonic machining, the rate of penetration is dependent on

(i) flow path

(ii) slurry

(iii) area of tool tip

(iv) All of the above

(c) Slurry used in USM is

(i) alkaline only

(ii) alcohol based

(iii) mercury based

(iv) water based

(d) Erosion of metal in EDM is

(i) proportionate to the number of sparks

(ii) continuous

(iii) Either of the above

(iv) None of the above

(e) AJM is used for

(i) plastic only

(ii) ductile materials only

(iii) brittle materials only

(iv) Any of the above

(f) Abrasive jet machining uses a jet of

(i) abrasive particles suspended in oil

(ii) fine-grained abrasive particles mixed with air or some other carrier gases at high pressure

(iii) abrasive particles suspended in water

(iv) None of the above

(g) In abrasive jet machining (AJM), metal removal takes place due to

(i) machining

(ii) grinding

(iii) metal erosion

(iv) All of the above

(h) In EDM, the required property of tool is

(i) resistivity

(ii) dielectric strength

(iii) conductivity

(iv) None of the above

(i) LASER welding finds wide application in

(i) electronic industry

(ii) heavy industry

(iii) structural work

(iv) None of the above

(j) LASER is produced by

(i) aluminium

(ii) ruby

(iii) diamond

(iv) graphite

2. (a) Explain, why conventional machining processes are used. 7

(b) List the important characteristics of EDM. 7

3. Explain, with a neat sketch, the principle and working of electrochemical machining (ECM) process. 14

4. What is the working principle of electron beam welding with neat sketch? What are its advantages, limitation and applications? 14

5. Explain clearly, with a neat diagram, abrasive jet machining (AJM). State also its advantages, disadvantages and application. 14

6. Explain the working principle of electric discharge machining (EDM) with neat sketch and explain the effects of EDM on metal surfaces. 14

7. Write short notes on any *two* of the following : 7×2=14

(a) Plasma-arc welding

(b) Laser-beam welding

(c) Underwater welding

8. Describe the explosive forming and magnetic forming processes with neat sketch. 14

9. Explain briefly, with a neat sketch, the principle and working of ultrasonic machining (USM). List also its advantages, limitation and applications. 14

* * *

Code : 021617

B.Tech 6th Semester Examination, 2017

Non Conventional Manufacturing

Time : 3 hours *Full Marks : 70*

Instructions :

*(i) There are **Nine** Questions in this Paper.*

*(ii) Attempt **Five** questions in all.*

*(iii) **Question No. 1 is Compulsory.***

(iv) The marks are indicated in the right-hand margin.

1. Answer/Choose the most appropriate option of the following **(any seven)** : 2×7=14

(A) Which of the following is a non-traditional machining method?

(a) Milling (b) Drilling

(c) Grinding (d) ultrasonic machining

(B) The gap between nozzle tip and workpiece in abrasive jet machining is approximately equal to

(a) 1 mm (b) 1 cm

(c) 1 m (d) 2 m

(C) Which of the following method uses very high frequency vibration for machining?

(a) Abrasive jet machining

(b) Ultrasonic machining

(c) Electric discharge machining

(d) Electrochemical machining

(D) The purpose of using sodium bicarbonate powder in abrasive jet machining is

(a) to clean the cut

(b) to increase the cutting efficiency

(c) to act as mixer for abrasive particles

(d) to provide neutral atmosphere around the jet.

(E) Consider the following statements:

(i) Abrasive jet machining uses finer abrasive particles as compared to abrasive water jet machining.

(ii) Nitrogen and carbon dioxide are used to mix abrasive particles in abrasive jet machining.

(iii) Abrasive jet machining finds applications in food industries.

(iv) Abrasive jet machining is used to cut softer materials.

of these statements:

(a) (i) and (ii) are true (b) (iii) and (iv) are true

(c) (ii) and (iii) are true (d) (i), (iii) and (iv) are true

(F) Which of the following material can be used as tool material in EDM?

(i) Copper (ii) Brass

(iii) Graphite

Of these

(a) (i) and (ii) (b) (iii)

(c) (i), (ii) and (iii) (d) (ii) and (iii)

(G) Which of the following methods uses combination of electrical and chemical energy for machining?

(a) Ultrasonic machining

(b) Abrasive jet machining

(c) Electrochemical machining

(d) Electron beam machining.

(H) In electric discharge machining, better surface finish is obtained at

(a) Low frequency and low discharge current

(b) Low frequency and high discharge current

(c) High frequency and low discharge current

(d) High frequency and high discharge current

(I) The material removal in electrochemical machining varies

(a) Inversely proportional to the gap between work and tool electrode

(b) Inversely proportional to the square of the gap

(c) Directly proportional to the square of the gap

(d) Directly proportional to the gap.

(J) Ultrasonic machining removes material from the workpiece by

(a) Hammering action of abrasive particles

(b) Rubbing action between tool and workpiece

(c) High frequency sound

(d) High frequency eddy currents

2. (a) Write down the classification of unconventional machining processes on the basis of energy. 7

(b) What are the difference between conventional machining and unconventional machining processes? 7

3. (a) Explain the working principle of electric discharge machining (EDM) with neat sketch. 7

(b) Explain the advantage and disadvantage of EDM. 7

4. What is the function of an abrasive slurry in ultrasonic machining (USM)? Explain how the abrasive selection is made. 14

5. Explain the working principle of ultrasonic welding with neat sketch. What are the advantage and limitation? 14

6. What are the difference between leaser welding and electron beam welding? 14

7. What are the requirements of good weld ? Also write the condition to avoid the weld defect. 14

8. Explain explosive welding process. What are the advantage, limitation and its applications? 14

9. Write short notes on any two following: 14

(a) Explosive forming

(b) Under water welding

(c) Electromagnetic forming

***

Question Bank

1. What is the need for unconventional machining processes?
2. What are the characteristics of UCM processes?
3. What is meant by conventional machining processes?
4. What is meant by Unconventional machining processes?
5. Differentiate the conventional and unconventional machining processes in terms of principles. (or) Distinguish between traditional and non-traditional machining processes?
6. What are the various types of energy sources used in non-traditional machining techniques? Give examples for each. (or) How non – traditional machining processes are classified?
7. Identify the mechanism of material removal, transfer media and energy source for EDM.
8. Identify the mechanism of material removal, transfer media and energy source for ECM & ECG.
9. Identify the mechanism of material removal, transfer media and energy source for EBM.
10. Identify the mechanism of material removal, transfer media and energy source for LBM.
11. Identify the mechanism of material removal, transfer media and energy source for PAM.
12. Identify the mechanism of material removal, transfer media and energy source for USM.
13. Identify the mechanism of material removal, transfer media and energy source for AJM.
14. Identify the mechanism of material removal, transfer media and energy source for WJM.
15. Identify the energy source applied in the following processes: i) IBM ii) CHM iii) ECG iv) ECM v) EDM vi) EBM vii) AJM viii) LBM
16. What is the necessity for unconventional machining processes? (or) What are the importance of unconventional machining? (or) Enlist the requirement that demands the use of advanced machining process.
17. Explain the classification of Unconventional machining according to major energy source employed.
18. Name the unconventional machining processes which are i) used to remove maximum material ii) used to remove minimum material iii) consumes maximum power iv) consumes minimum power.
19. Name the unconventional machining processes for machining following materials: i) Non metals like ceramics, plastics and glass ii) Refractories iii) Titanium iv) super alloys v) steel.
20. Mention the best suited Unconventional machining process for the following operations:
21. Name the Unconventional machining processes which produce best surface finish.
22. Why conventional mechanical machining process is not so effective on soft metals like aluminium?
23. Name the important factors that should be considered during the selection of an unconventional machining process for a given job.
24. Write the importance of surface finishing in machining operations.

25. Classification of UCM (or) How are unconventional machining processes classified? (or)

What are the basic factors upon which the unconventional manufacturing processes are classified? Explain.

26. (i) Explain the factors that should be considered during the selection of an appropriate unconventional machining process for a given job. (ii) Compare and contrast the various unconventional machining process on the basis of type of energy employed, material removal rate, transfer media and economical aspects. (or) Classify unconventional machining processes based on basic mechanism involved in the process, sources of energy required for material removal, medium for transfer of energies and type of energy required shape materials.
27. Compare the mechanical and electrical energy processes in terms of physical parameters. Shape capabilities, Process capability, and Process economy. (or) Compare the process capabilities and limitations of electrical energy based, thermal energy based and mechanical energy based unconventional machining processes.
28. Explain the reasons for the development of Unconventional Machining Process. Discuss about the criteria recommended in selection of these processes. (or) Explain the need for the development of Unconventional Machining Process by considering any four simple cases of your own interest.
29. Make a comparison between traditional and unconventional machining processes in terms of cost, application, scope, Machining time, advantages and limitations.
30. For different non-conventional processes, present in the form of a table, various process parameters recommended.
31. i) What exactly are the items that can be considered with respect to the analysis of economics of various non – traditional machining processes? Briefly explain.

    ii) Make a comparison among various non - traditional machining processes in terms of the following. Presentation in the form of a table is preferred. a. Pocketing operation b. Contouring a surface.
32. How will you analyze the applicability of different processes to different type of materials namely metals, alloys and non metals? Presentation in the form of a table is preferred.
33. Is unconventional machining process an alternate or complement to conventional machining process? Justify.
34. What do you understand by the word “unconventional” in unconventional machining processes? Is it justified to use this word in the context of the utilization of these processes on the shop floor?
35. What are the abrasives used in AJM process?
36. What are the desirable properties of carrier gas in AJM?
37. List the applications of WJM process.
38. What is meant by transducer?
39. What is feed mechanism and state its types?
40. What is the effect of abrasive grain size on machining rate in USM?
41. What are the types of work materials for USM?
42. Define abrasive slurry.

43. Write the typical applications of ultrasonic machining.
44. State the principle of ultrasonic machining process?
45. State the benefits of Water Jet Machining process.
46. Define tool wear ratio.
47. Explain water jet machining process?
48. What are the factors that affect the material removal rate in AJM process?
49. State the applications of AJM process?
50. State the advantages and limitations of USM.
51. Explain the abrasives used in USM process?
52. What are the types of tool materials for USM?
53. What is water jet machining process?
54. State the working principle of HJM process.
55. State the working principle of Abrasive Jet Machining.
56. What is ultrasonic machining?
57. What are the components of USM?
58. What is piezoelectric effect?
59. Write short notes on piezoelectric crystals?
60. What is magnetostrictive effect?
61. What is the purpose of concentrator used in USM?
62. What are the types of transducers used in ultrasonic machining processes?
63. What is inverse Piezoelectric effect?
64. What are the different types of concentrators?
65. What are the characteristics of carrier fluid?
66. What are the elements of Carrier Fluid?
67. Name the carrier gas (Transfer medium) used in AJM process.
68. What are the materials used for nozzle manufacturing in AJM process?
69. List the Advantages and Disadvantages of AJM process.
70. List the benefits and disadvantages of WJM process.
71. How does AJM differ from conventional sand blasting process?
72. Give a summary of the abrasive of their application for different operation?
73. Explain the principle of USM and its equipment. Explain the factors, which influence the MRR in USM. Compare USM with traditional Abrasive machining.
74. Explain the following in detail i) Types of transducers for USM ii) Feed mechanisms in USM iii) USM typical applications iv) Abrasives for USM
75. Describe the principle and equipment for Abrasive Jet machining. (OR) Write the names of various elements of AJM and explain them in brief.
76. Explain the process parameter which controls the AJM machining quality.(or) With a neat sketch explain the process of AJM? Explain the process control measures to be taken to control quality and MRR.
77. i) Describe the principle and equipment for Water Jet Machining.
    ii) Explain the different applications and process control features of WJM.
78. Explain the functions of Transducer and horns used in USM. List the tool materials used.

79. Briefly explain the effect of operating parameters on MRR. List the applications of USM.
80. Discuss the process parameters, applications, advantages and disadvantages of water jet machining process.
81. Describe the principle and working of a USM with a neat sketch. List the advantages, limitations and applications of USM. Discuss about the control of quality in machining in USM.
82. Discuss the effects of the following parameters on MRR and surface finish in USM: i) amplitude and frequency ii) Abrasive size iii) Concentration of abrasives iv) Material hardness v) static load vi) effect of slurry, tool and work material.
83. Compare USM, WJM and AJM in terms of process capabilities and limitations.
84. Discuss about the control of quality in USM and the capabilities of USM.
85. Briefly explain about the mechanisms involved in material removal by USM.
86. What is the fundamental principle of abrasive jet machining? Briefly explain with a neat
87. diagram, the AJM process. In AJM, how is material removal rate increased? Also state how nozzle life is improved in such a machining process.
88. i) Make a comparison between ultrasonic machining and conventional grinding.
89. ii) What are the actions do the ultrasonic vibrations imparted to the fluid medium surrounding the tool have?
90. Draw the schematic layout of AJM and explain its operating characteristics. What are the methods adopted to have an effective control over the mass flow rate of the abrasive?
91. Define electrical discharge machining?
92. What are functions of dielectric fluid used in EDM?
93. What are the basic requirements of dielectric fluid used in EDM?
94. What is the dielectric fluids commonly used in EDM?
95. What are the prime requirements of tool material in EDM?
96. What is the effect of capacitance in EDM?
97. Name some of the tool material used in EDM?
98. What are the process parameters which affect efficiency?
99. Write the formula for finding the energy discharge in EDM?
100. How do you increase the inductance of the circuit?
101. Define W/T (Tool Wear) ratio?
102. What is cycle time?
103. Define over cut?
104. Define Rehardening?
105. What is recast metal?
106. Explain electrode wear?
107. What are types of power supply circuits used in EDM?
108. What are the design factors to be considered while selecting the machine tool?
109. Why the servo controlled system is needed in EDM?
110. Define electrical discharge machining?
111. What are the factors affecting metal removal rate?
112. How the tool materials are classified?

113. Indicate the range of pulse duration and current in EDM.
114. What are the principal components of EDM process?
115. Name the most commonly used spark generating circuits.
116. Give the wear ratio for Brass, Copper, copper tungsten and non metallic electrode.
117. What are the drawbacks of using Relaxation circuit?
118. What is tool wear in EDM? How does tool wear occur in EDM?
119. How to minimize tool wear in EDM?
120. Identify the characteristics of an electrode material in order to serve as a good tool.
121. What are the advantages and limitations of EDM?
122. What is an arc gap? How is the arc gap controlled in EDM?
123. List the applications of EDM.
124. List the advantages and disadvantages of wire – cut EDM
125. List the applications of WEDM.
126. What is meant by wire cut EDM? Mention its salient feature.
127. With the help of a neat sketch, explain the working of a spark erosion machine. (or) With the help of neat sketch, describe the EDM process.
128. What are the desirable properties of a dielectric fluid? Give some examples for dielectric fluids. Explain the functions of dielectric fluid.
129. What are the important process parameters that control the material removal rate in EDM? Explain any four factors
130. Explain the process of wire cut EDM and list any two of its advantages, limitations and applications. (or) Explain the process of wire cut EDM with respect to process equipment, applications, advantages and limitations.
131. Explain the process of Electrical discharge grinding (EDG) and list any two of its advantages, limitations and applications.
132. Explain the process of Electrical discharge wire cutting processes and list any two of its advantages, limitations and applications.
133. Explain the different types of power generator circuits in EDM.
    a. Explain the servo system used to control the feed rate in EDM process.
    b. With a typical component explain the working of a wire EDM system.
134. List out the three types of spark generators used in EDM. Describe them.
135. Explain how MRR and quality is controlled in EDM process.
136. List the recent developments in EDM process and state the limitations of EDM process.
137. Explain the classification and characteristics of various spark erosion generators?
138. Explain the working principle, elements and characteristics of wire EDM.
139. Draw and explain the relaxation circuit (RC) used in EDM process?
140. Sketch and discuss the effects of the following parameters on MRR during EDM
    c. Pulse duration on material removal rate,
    d. Surface finish and relative electrode wear rate
141. With the help of a neat diagram the sequence of events constituting the process of metal
142. removal from the work piece by a single discharge in EDM process?

143. Explain the following on wire EDM technology: i) Dielectric system ii) Deionized water iii) Positioning system iv) Wire drive system.
144. Write the Faraday's first law of electrolysis?
145. Write the Faraday's second law of electrolysis?
146. Write Ohm's law?
147. What are the factors that influence oxidation in ECM?
148. What are the materials used to make the tool electrode? (or) What are the materials used for
149. tools in ECM?
150. What are the main functions of electrolysis in the ECM?
151. What are the properties are expected from the electrolysis used in the ECM?
152. What are the electrolytes commonly used in ECM?
153. What are the results due to improper selection of electrolyte in ECM?
154. What are the methods generally used to filter the electrolyte?
155. What are the characteristics(requirements) of a good ECM tool?
156. What are the parameters that affect the MRR?
157. How the current density affects the MRR?
158. What are the advantages and Disadvantages of ECM?
159. What are the applications of ECM?
160. Define ECG. (or) State the principle of ECG process.
161. Which material is used to make the grinding wheel?
162. What are the important functions of abrasive particles used in ECG?
163. What are the advantages and disadvantages of ECG?
164. What are the limitations of ECG?
165. What is the application of ECG?
166. State the principle of chemical machining process.
167. Write the principle of ECM process.
168. What are the factors to be considered while designing the tool?
169. Compare the CHM with ECM with respect to their process parameters.
170. Describe the Laser Beam Machining equipment and Electron Beam Machining equipment. Explain the production of laser beam and working principle of LBM?
171. What are the applications of EBM process?
172. Explain the features of EBM unit. Explain the effect of increasing the accelerating potential on MRR.
173. Explain the process of LBM and PAM with neat sketches.
174. Discuss the process parameters of EBM and their influence on Machining quality.
175. Explain the principle of LBM with neat sketch and list out the advantages and disadvantages?
176. Explain the process of PAM with a neat sketch. With respect to principle, equipment process parameter, advantages, disadvantages and applications.
177. Explain the thermal features of Laser beam machining. Discuss the performance of various types of Lasers.

178. Discuss about the process capabilities of EBM and the process parameters of EBM in improving machining quality.
179. i) What are the unique characteristics a Laser machining technique possesses that make it the only choice for the job? ii) What is meant by “optical pumping” briefly explain the “population inversion between energy levels” with respect to laser beam machining?
180. Why is EBM carried out in vacuum? Explain the process with a neat sketch.
181. Explain the production of Laser beam and working principle of LBM process.
182. Write short notes on: i. Process characteristics of EBM ii. Why vacuum is need and what is its order in EBM process iii. What is spontaneous emission and what is laser? iv. Advantages of laser
183. What are the types of laser used for material processing applications? Describe how the system can be used for machining purpose.
184. Make a comparison between LBM and EDM on the basis of their application and limitation.
185. Explain the principle, construction and working of electron beam machining. Also how a
186. complex shape can be cut using EBM process.
187. With the help of a neat diagram, explain plasma arc machining process mentioning how heating of the work piece takes place in the process

Non-traditional Machining Processes

Manufacturing processes can be broadly divided into two groups:

a) primary manufacturing processes : Provide basic shape and size

b) secondary manufacturing processes : Provide final shape and size with tighter control on dimension, surface characteristics

Material removal processes once again can be divided into two groups

1. Conventional Machining Processes
2. Non-Traditional Manufacturing Processes or non-conventional Manufacturing processes

Conventional Machining Processes mostly remove material in the form of chips by applying forces on the work material with a wedge shaped cutting tool that is harder than the work material under machining condition.

Non-traditional Machining Processes

The major characteristics of conventional machining are:

- Generally macroscopic chip formation by shear deformation
- Material removal takes place due to application of cutting forces – energy domain can be classified as mechanical
- Cutting tool is harder than work piece at room temperature as well as under machining conditions

Non-conventional manufacturing processes is defined as a group of processes that remove excess material by various techniques involving mechanical, thermal, electrical or chemical energy or combinations of these energies but do not use a sharp cutting tools as it needs to be used for traditional manufacturing processes.

The major characteristics of Non-conventional machining are:

1. Material removal may occur with chip formation or even no chip formation may take place. For example in AJM, chips are of microscopic size and in case of Electrochemical machining material removal occurs due to electrochemical dissolution at atomic level.

Non-traditional Machining Processes

The major characteristics of Non-conventional machining:

2. In NTM, there may not be a physical tool present. For example in laser jet machining, machining is carried out by laser beam. However in Electrochemical Machining there is a physical tool that is very much required for machining
3. In NTM, the tool need not be harder than the work piece material. For example, in EDM, copper is used as the tool material to machine hardened steels.
4. Mostly NTM processes do not necessarily use mechanical energy to provide material removal. They use different energy domains to provide machining. For example, in USM, AJM, WJM mechanical energy is used to machine material, whereas in ECM electrochemical dissolution constitutes material removal.

Classification of NTM processes

classification of NTM processes is carried out depending on the nature of energy used for material removal.

1. Mechanical Processes

- Abrasive Jet Machining (AJM)
- Ultrasonic Machining (USM)
- Water Jet Machining (WJM)
- Abrasive Water Jet Machining (AWJM)

2. Electrochemical Processes

- Electrochemical Machining (ECM)
- Electro Chemical Grinding (ECG)
- Electro Jet Drilling (EJD)

3. Electro-Thermal Processes

- Electro-discharge machining (EDM)
- Laser Jet Machining (LJM)
- Electron Beam Machining (EBM)

4. Chemical Processes

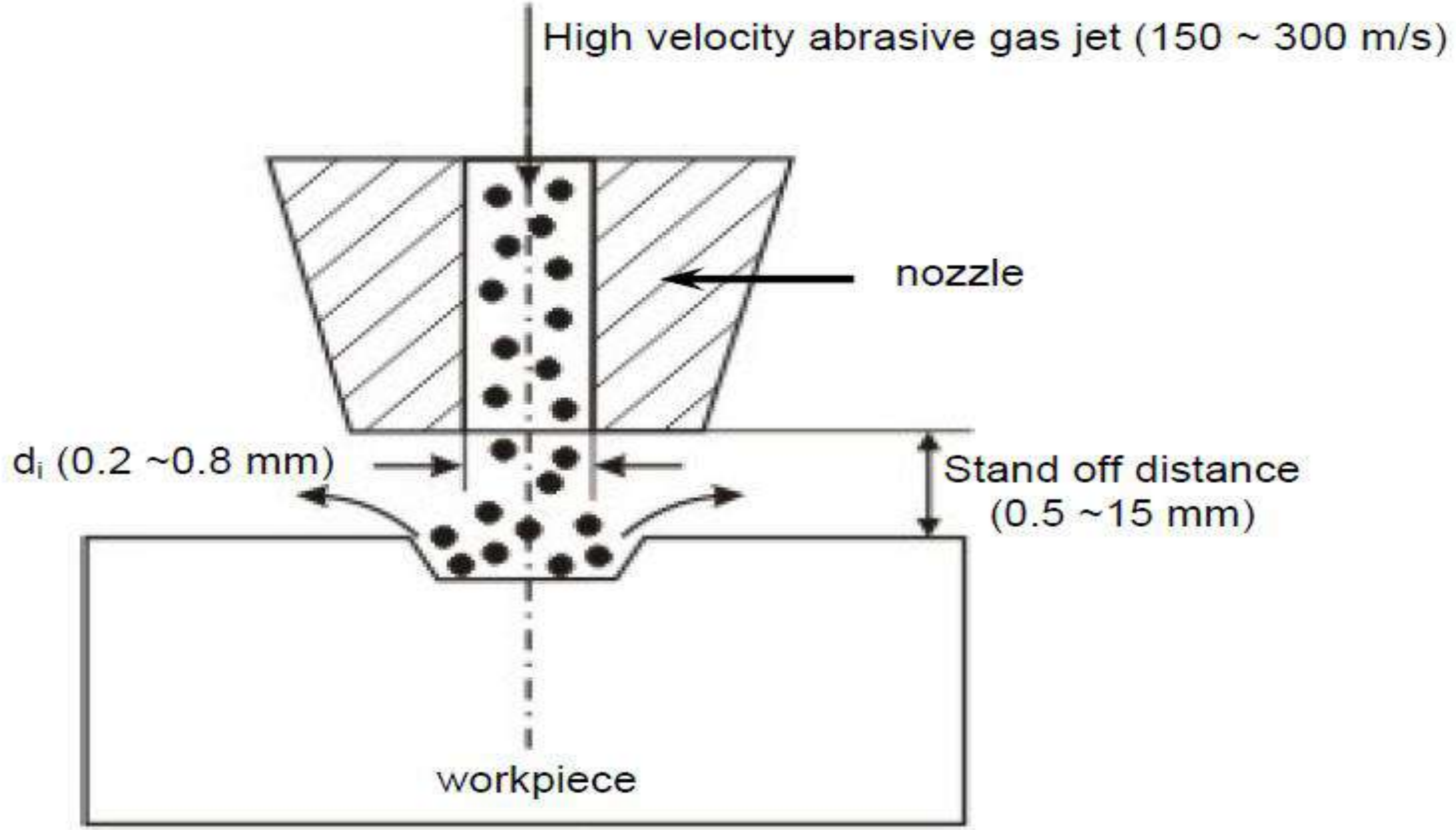
- Chemical Milling (CHM)
- Photochemical Milling (PCM)

Needs for Non Traditional Machining

- Extremely hard and brittle materials or Difficult to machine materials are difficult to machine by traditional machining processes.
- When the workpiece is too flexible or slender to support the cutting or grinding forces.
- When the shape of the part is too complex.
- Intricate shaped blind hole – e.g. square hole of 15 mmx15 mm with a depth of 30 mm
- Deep hole with small hole diameter – e.g. φ 1.5 mm hole with l/d = 20
- Machining of composites.

Abrasive Jet Machining

In Abrasive Jet Machining (AJM), abrasive particles are made to impinge on the work material at a high velocity. The high velocity abrasive particles remove the material by micro-cutting action as well as brittle fracture of the work material.

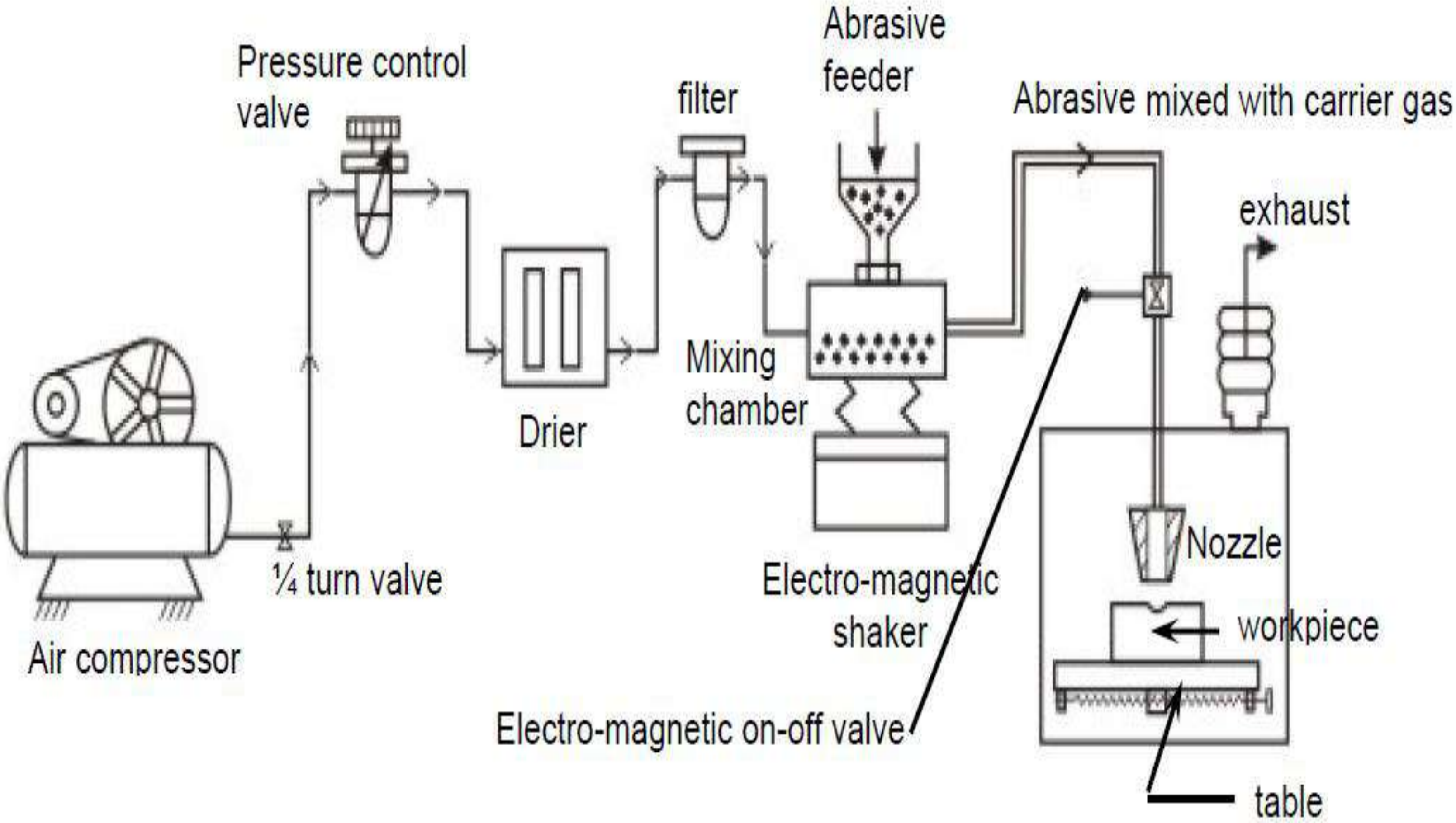


AJM

Abrasive Jet Machining

In AJM, generally, the abrasive particles of around 50 μm grit size would impinge on the work material at velocity of 200 m/s from a nozzle of I.D. of 0.5 mm with a stand off distance of around 2 mm. The kinetic energy of the abrasive particles would be sufficient to provide material removal due to brittle fracture of the work piece or even micro cutting by the abrasives.

Abrasive Jet Machining



AJM set-up

Abrasive Jet Machining

Process Parameters and Machining Characteristics

Abrasive : Material – Al_2O_3 / SiC

Shape – irregular / spherical

Size – 10 ~ 50 μm

Mass flow rate – 2 ~ 20 gm/min

Carrier gas : Composition – Air, CO_2, N_2

Density – Air ~ 1.3 kg/m3

Velocity – 500 ~ 700 m/s

Pressure – 2 ~ 10 bar

Flow rate – 5 ~ 30 lpm

Abrasive Jet : Velocity – 100 ~ 300 m/s

Mixing ratio – mass flow ratio of abrasive to gas

Stand-off distance – 0.5 ~ 5 mm

Impingement Angle – 60^0 ~ 90^0

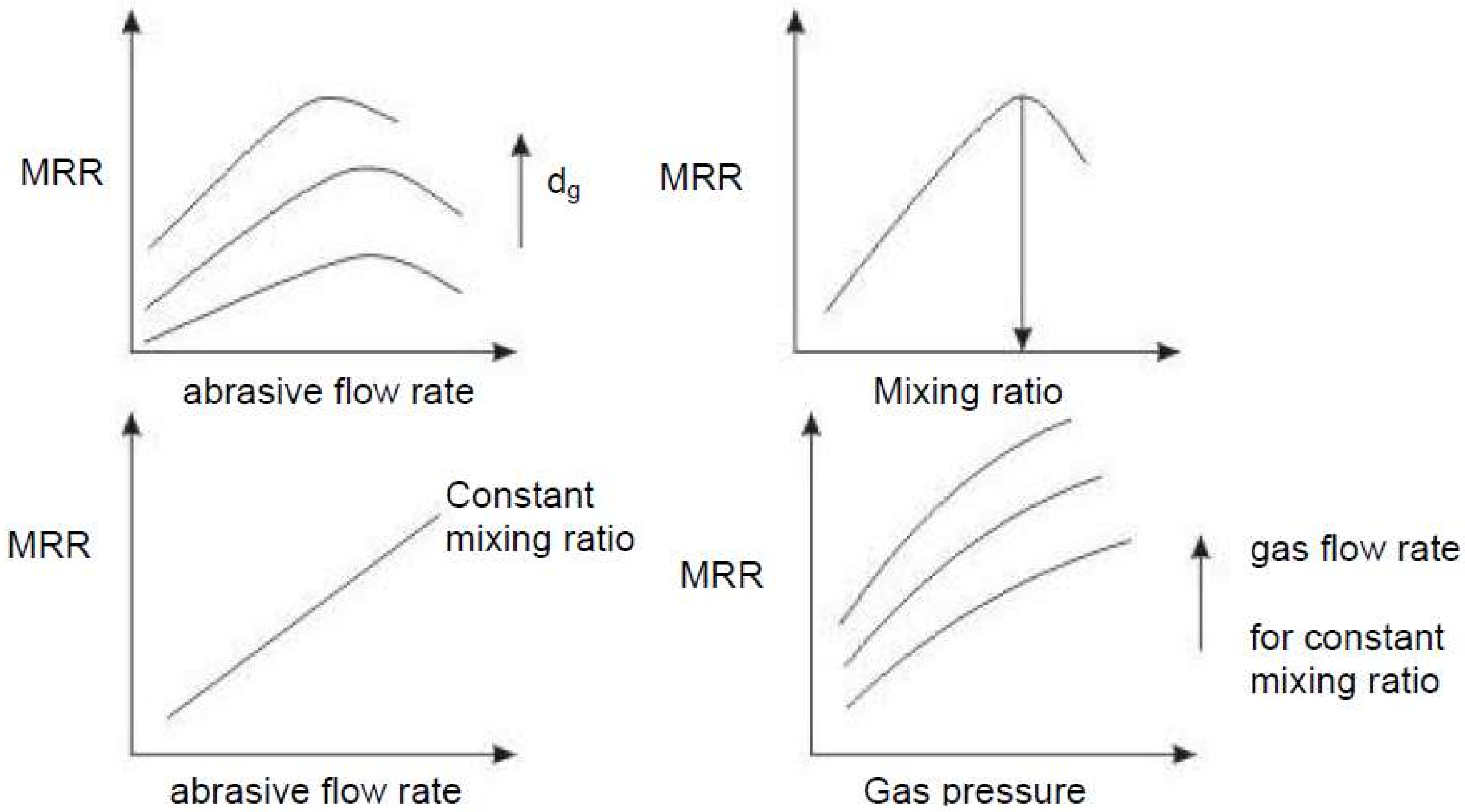
Nozzle : Material – WC

Diameter – (Internal) 0.2 ~ 0.8 mm

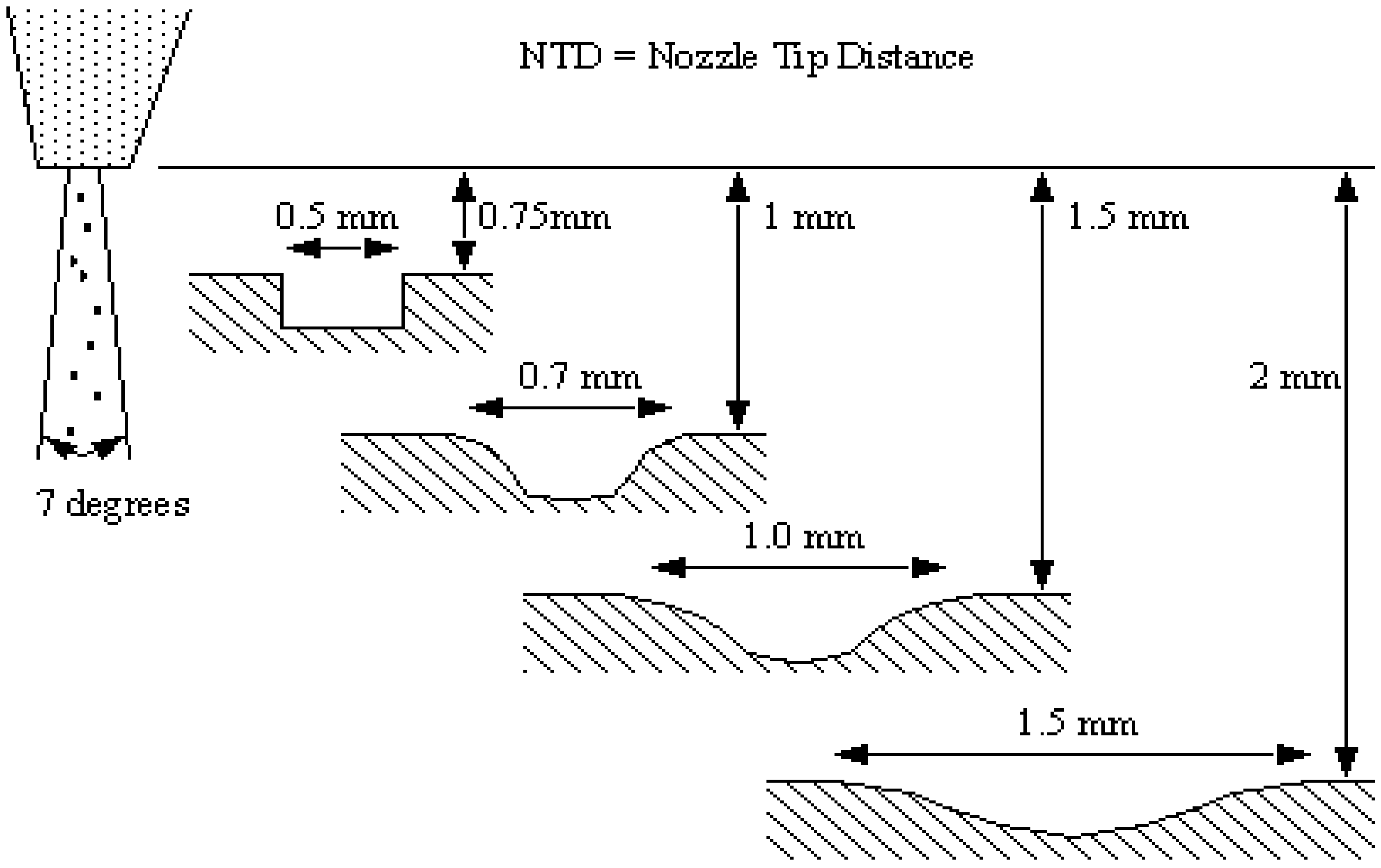
Life – 10 ~ 300 hours

Abrasive Jet Machining

effect of process parameters on MRR



Abrasive Jet Machining



Abrasive Jet Machining

Modelling of material removal

Material removal in AJM takes place due to brittle fracture of the work material due to impact of high velocity abrasive particles.

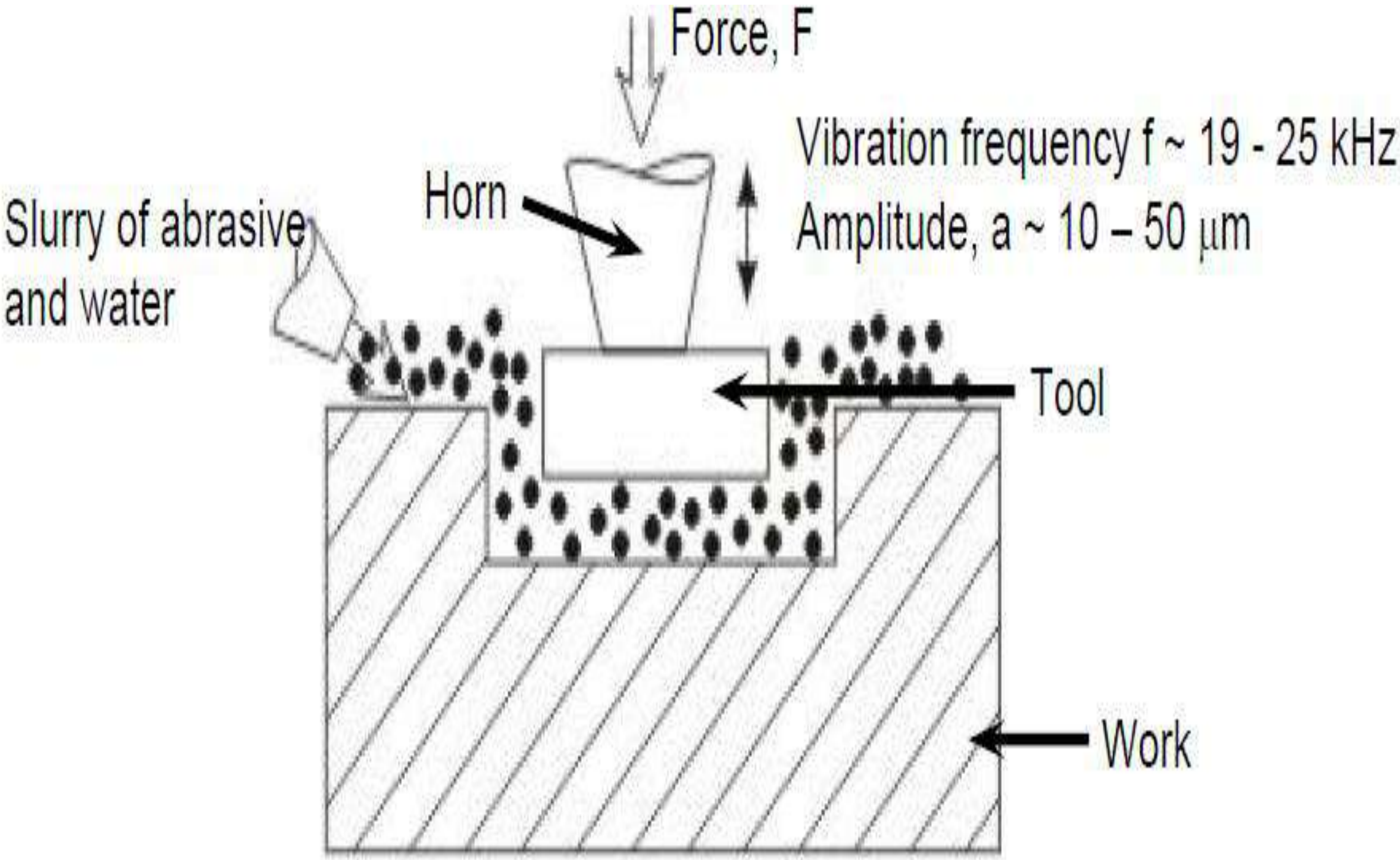
Modelling has been done with the following assumptions:

(i) Abrasives are spherical in shape and rigid. The particles are characterised by the mean grit diameter

(ii) The kinetic energy of the abrasives are fully utilised in removing material

(iii) Brittle materials are considered to fail due to brittle fracture and the fracture volume is considered to be hemispherical with diameter equal to chordal length of the indentation

(iv) For ductile material, removal volume is assumed to be equal to the indentation volume due to particulate impact.


Force, F
Vibration frequency f ~ 19 - 25 kHz
Amplitude, a ~ 10 – 50 μm
Horn
Slurry of abrasive
and water
Tool
Work

USM

- USM for machining brittle work material
- Material removal primarily occurs due to the indentation of the hard abrasive grits on the brittle work material.
- Other than this brittle failure of the work material due to indentation some material removal may occur due to free flowing impact of the abrasives against the work material and related solid-solid impact erosion,
- Tool's vibration – indentation by the abrasive grits.
- During indentation, due to Hertzian contact stresses, cracks would develop just below the contact site, then as indentation progresses the cracks would propagate due to increase in stress and ultimately lead to brittle fracture of the work material under each individual interaction site between the abrasive grits and the workpiece.
- The tool material should be such that indentation by the abrasive grits does not lead to brittle failure.
- Thus the tools are made of tough, strong and ductile materials like steel, stainless steel and other ductile metallic alloys.

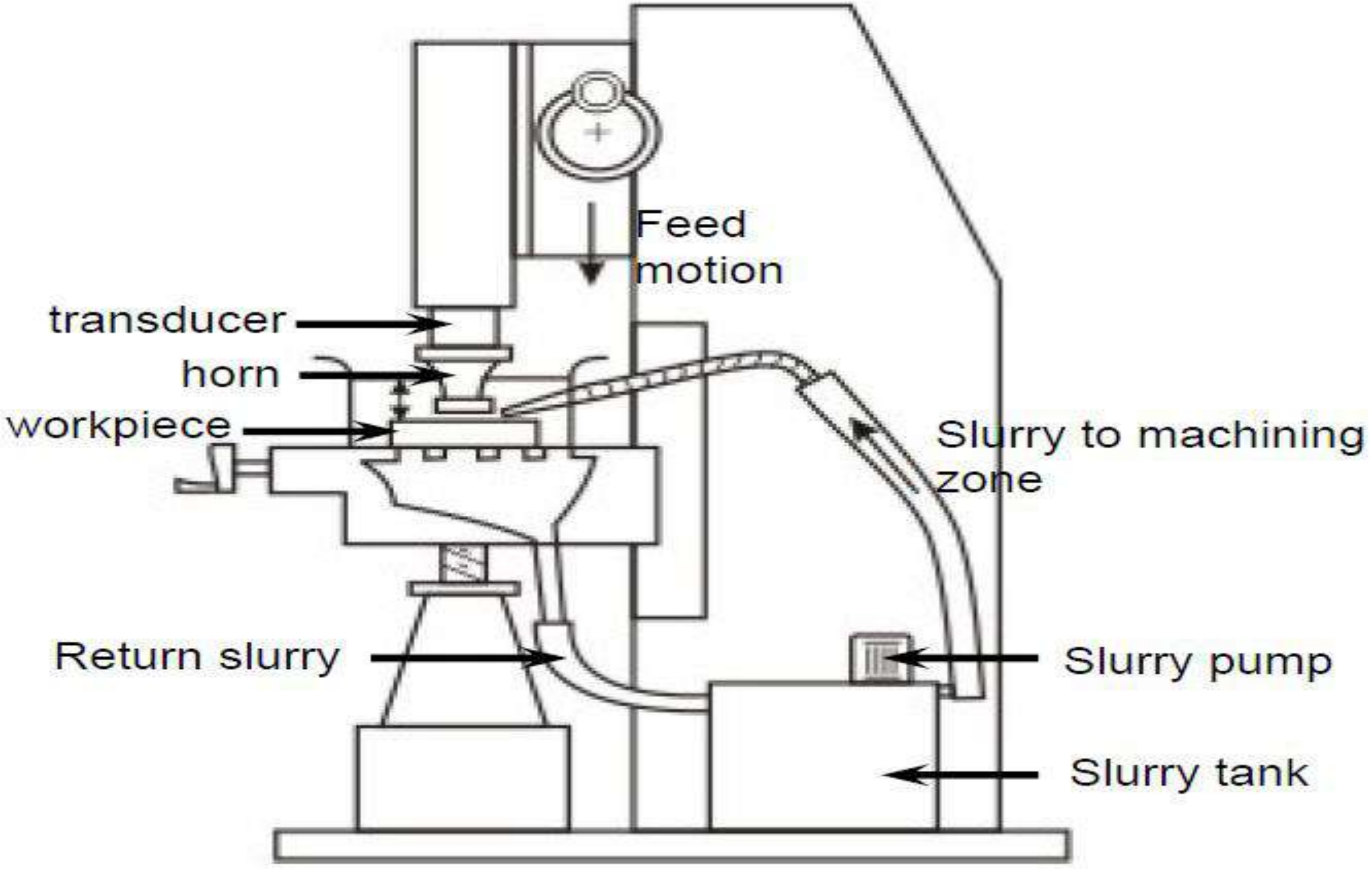
USM

- Process variables:

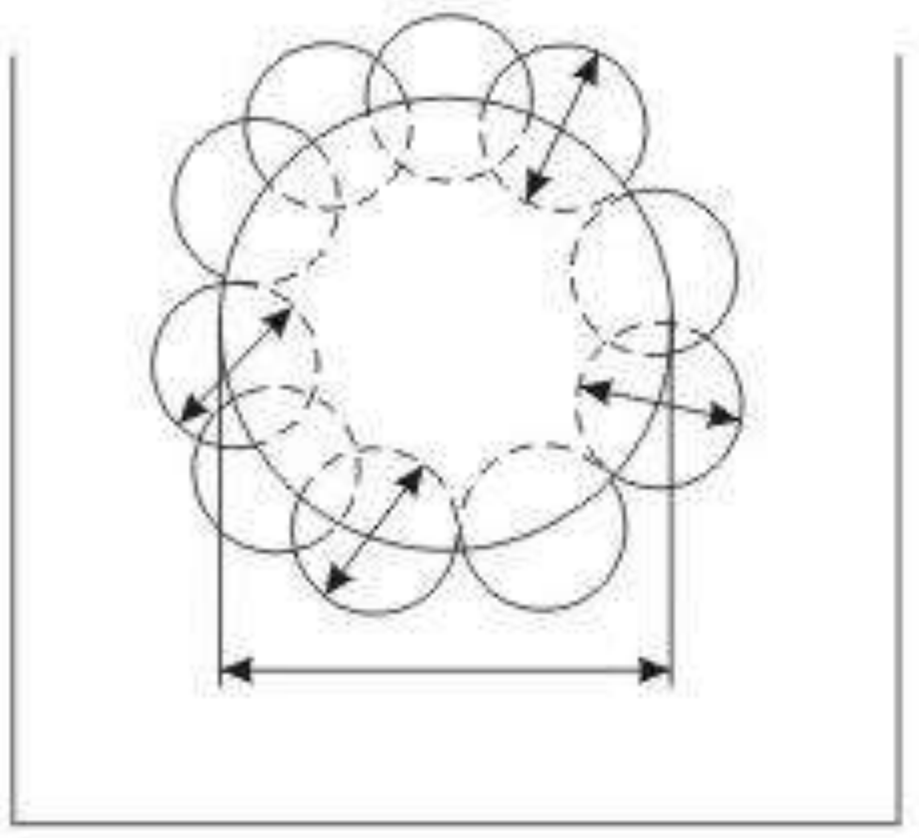
- Amplitude of vibration (a_o) – 15 – 50 μm
- Frequency of vibration (f) – 19 – 25 kHz
- Feed force (F) – related to tool dimensions
- Feed pressure (p)
- Abrasive size – 15 μm – 150 μm
- Abrasive material – Al_2O_3
  - SiC
  - B_4C
  - Boronsilicarbide
  - Diamond

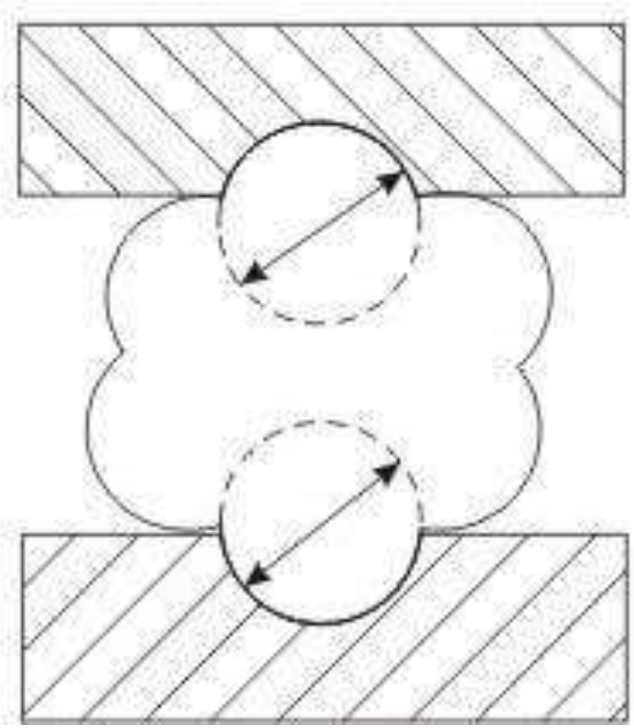
  Flow strength of work material
  Flow strength of the tool material
  Contact area of the tool – A
  Volume concentration of abrasive in water slurry – C

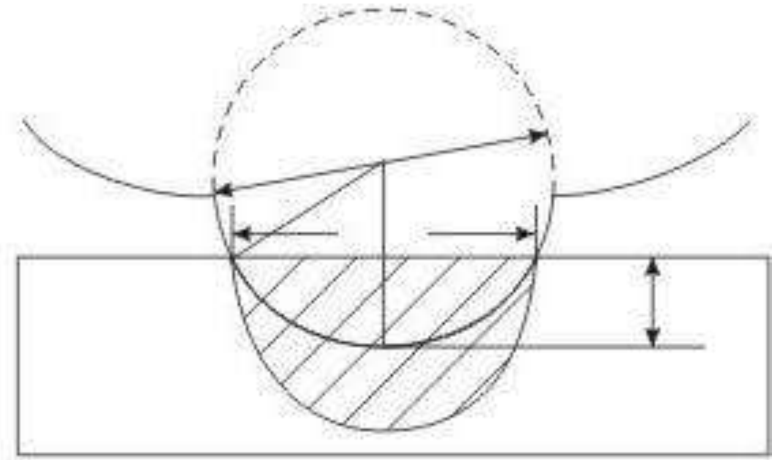
USM Equipment



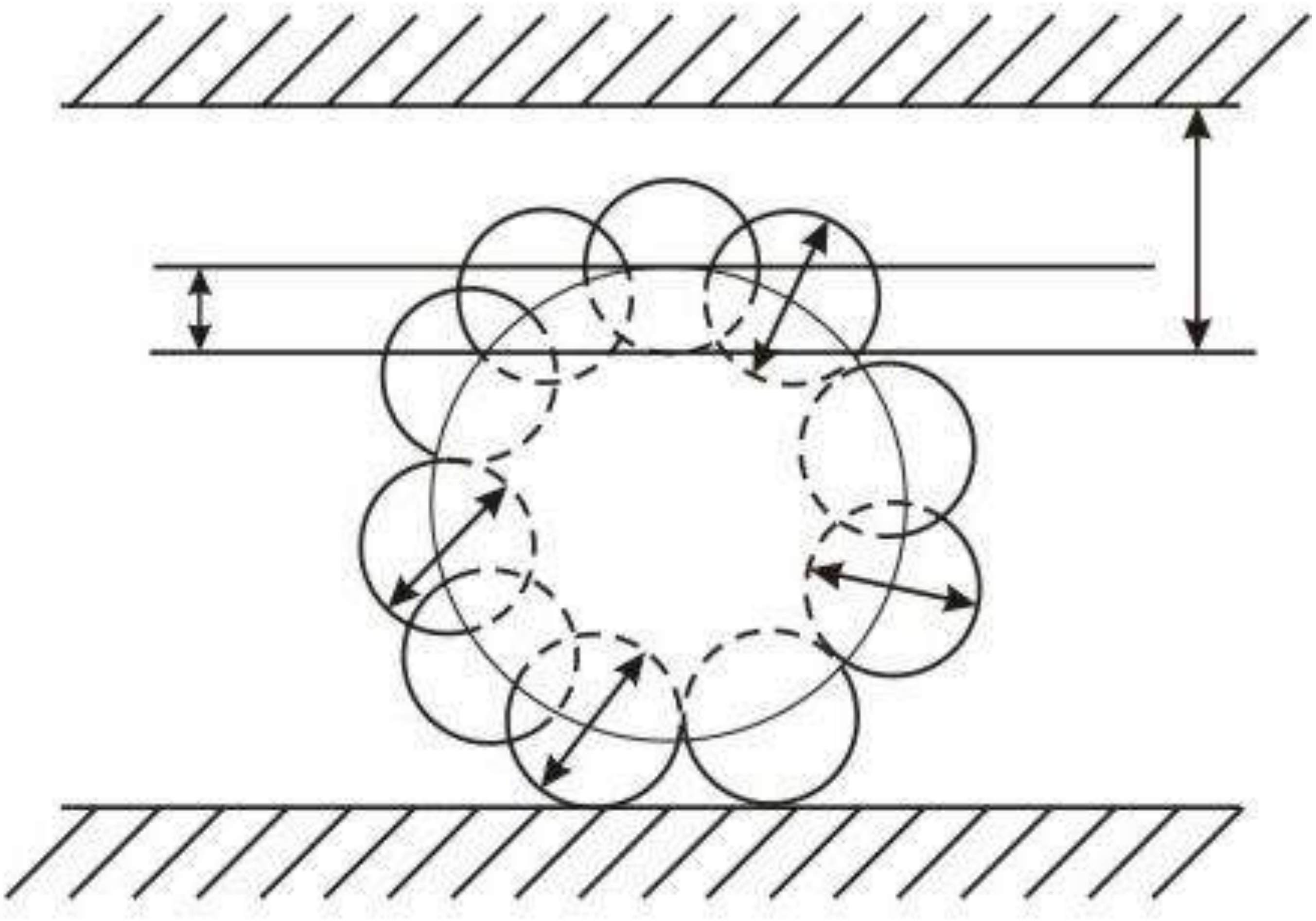
Modelling



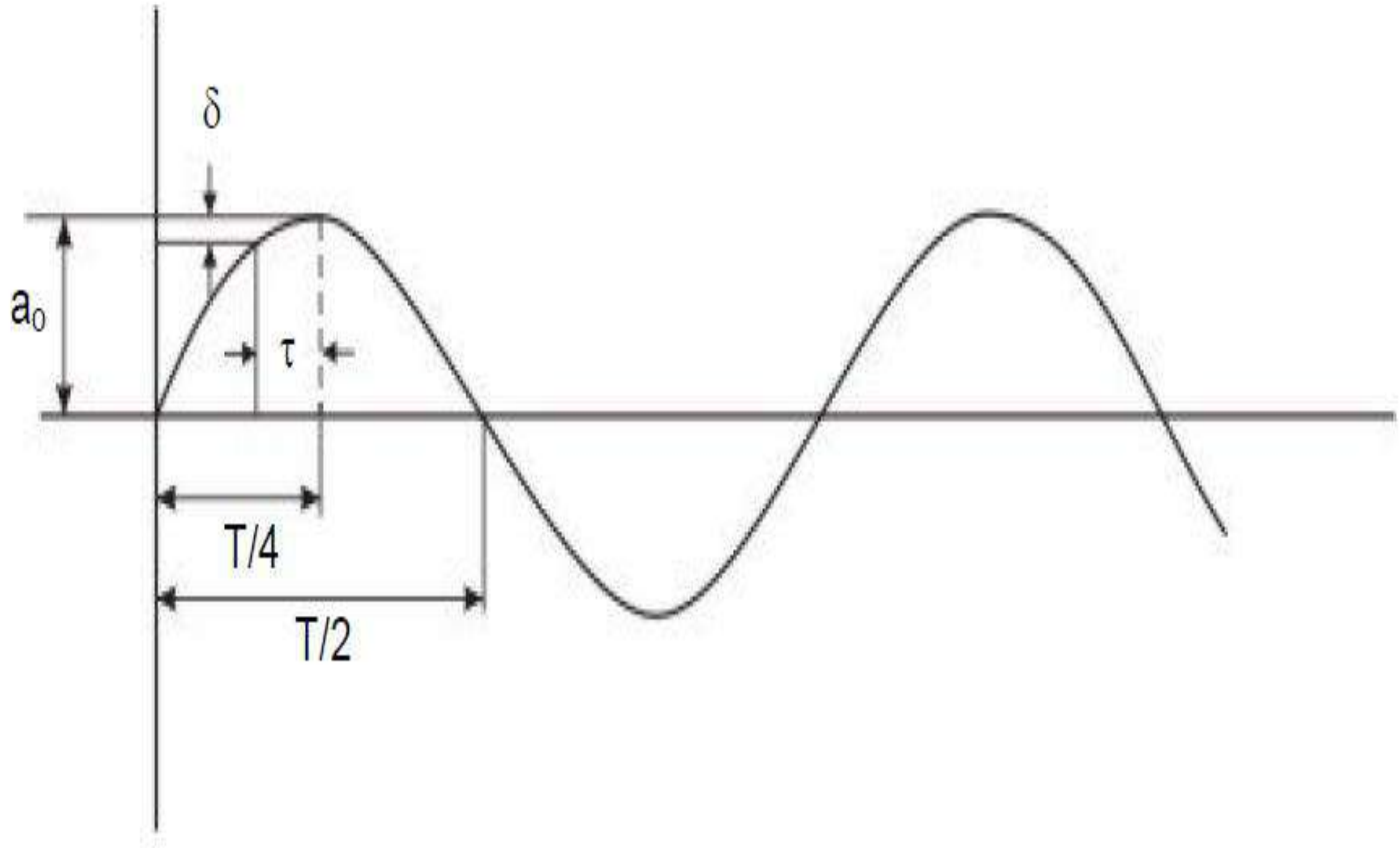




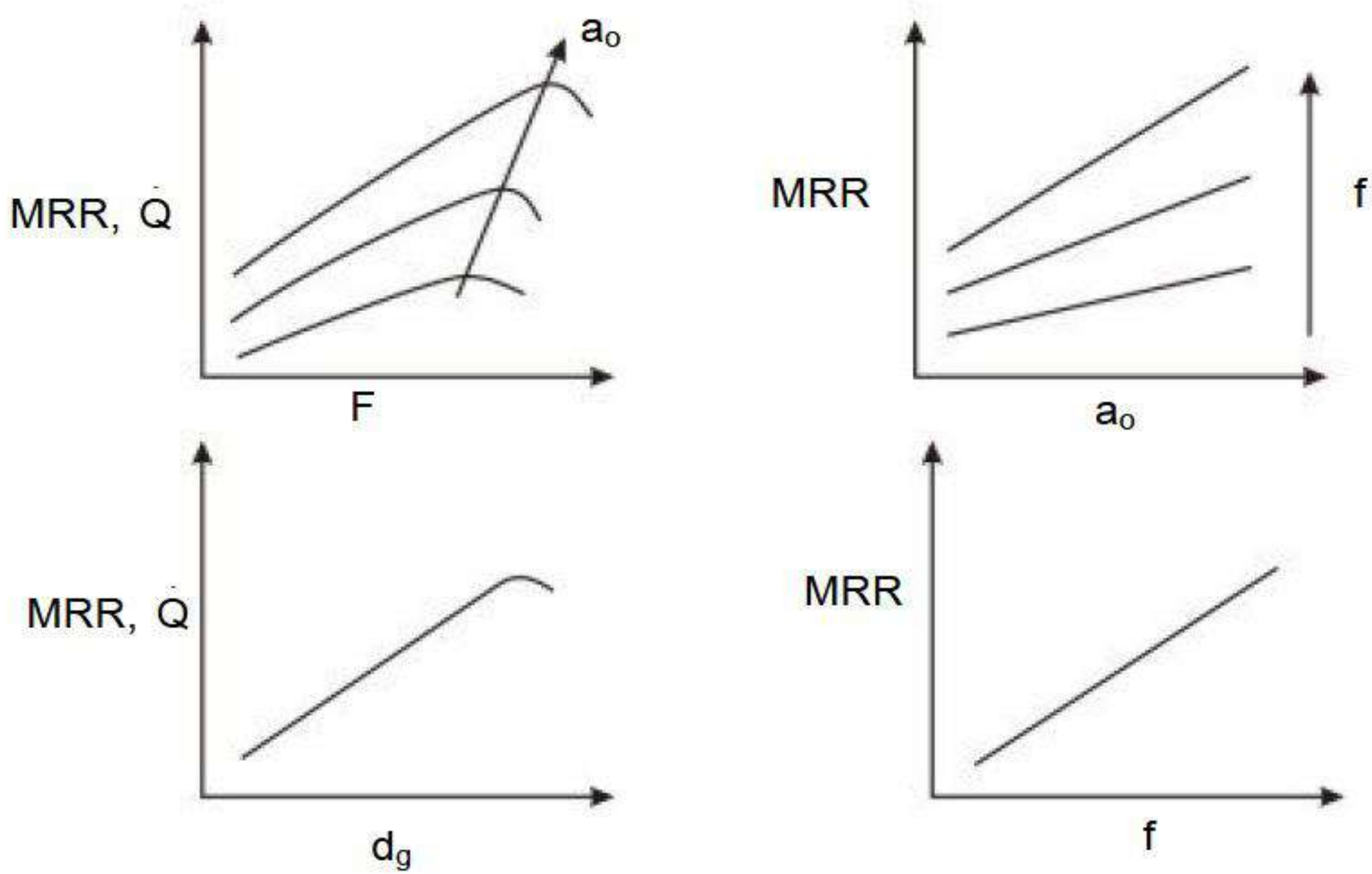
Modelling



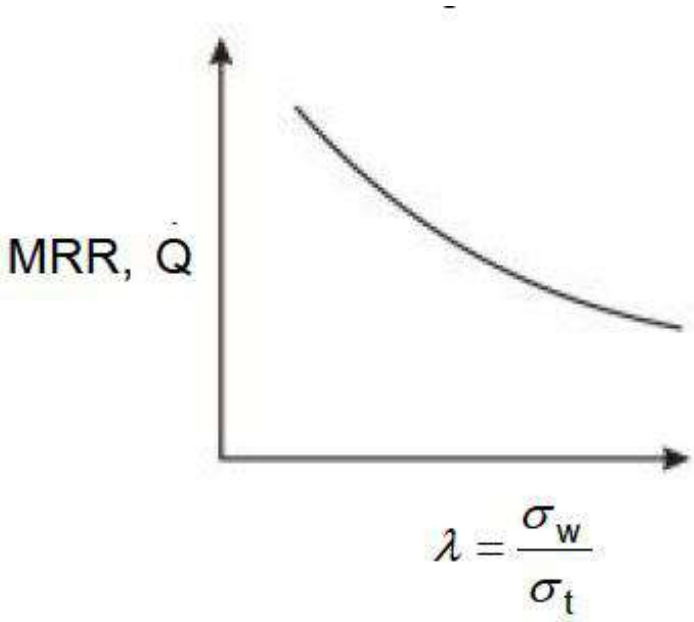
Modelling

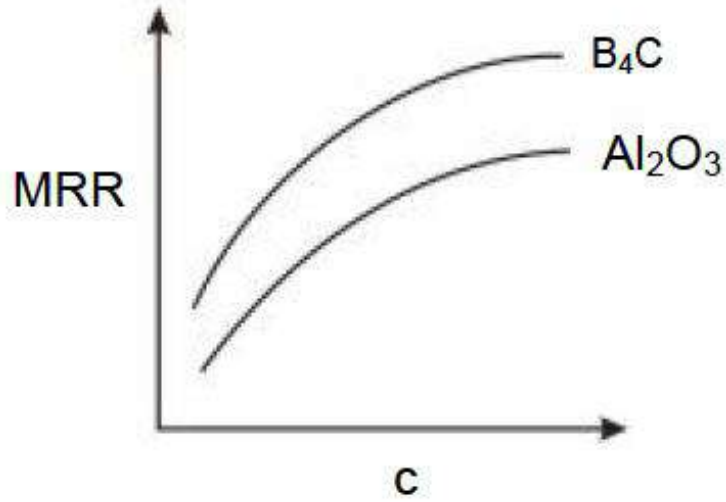


Modelling

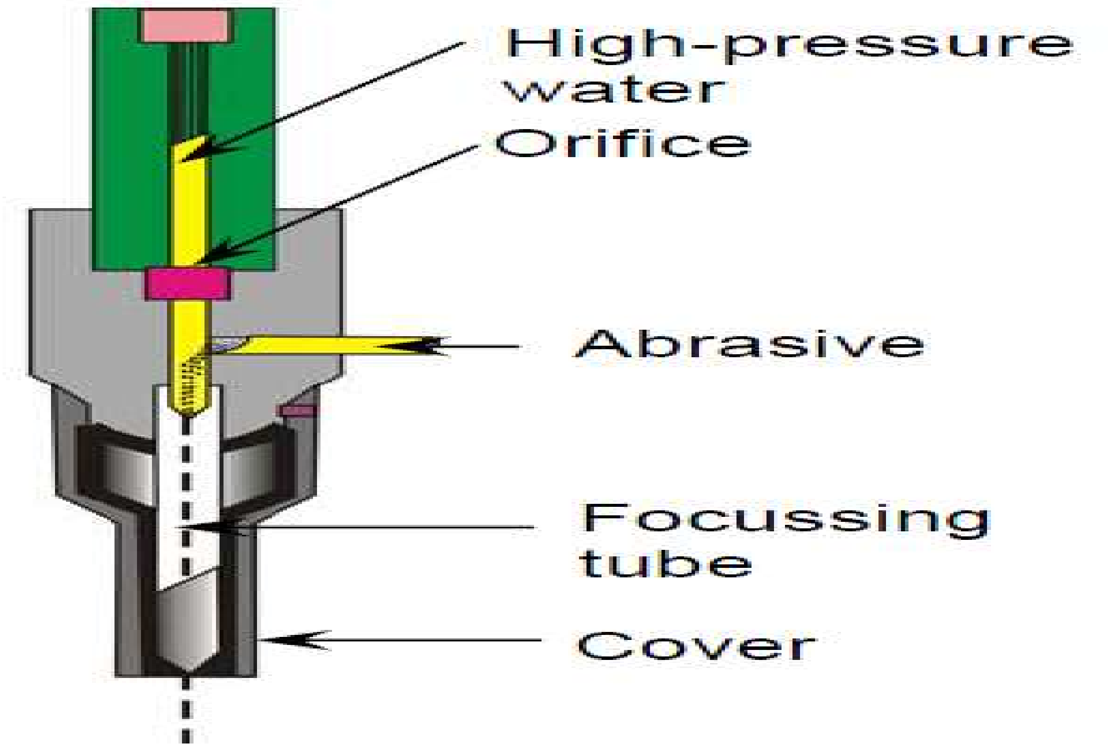


Modelling





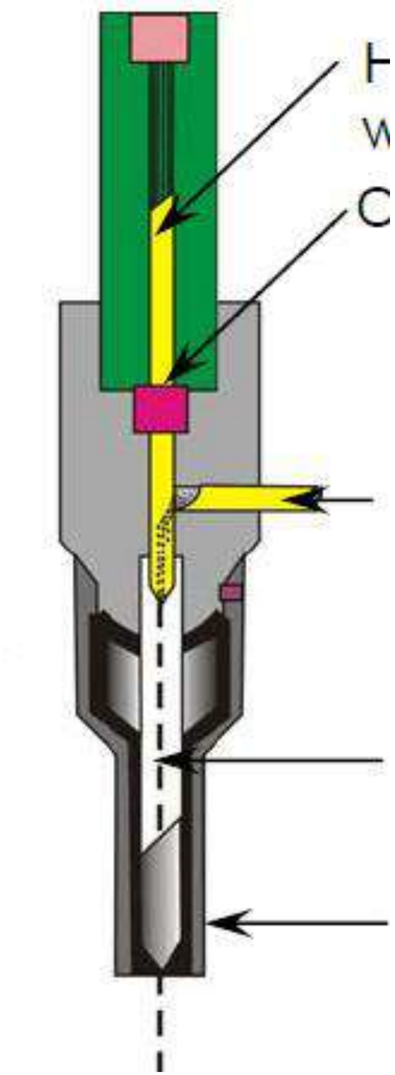
Water Jet and Abrasive Water Jet Machining



Water Jet and Abrasive Water Jet Machining

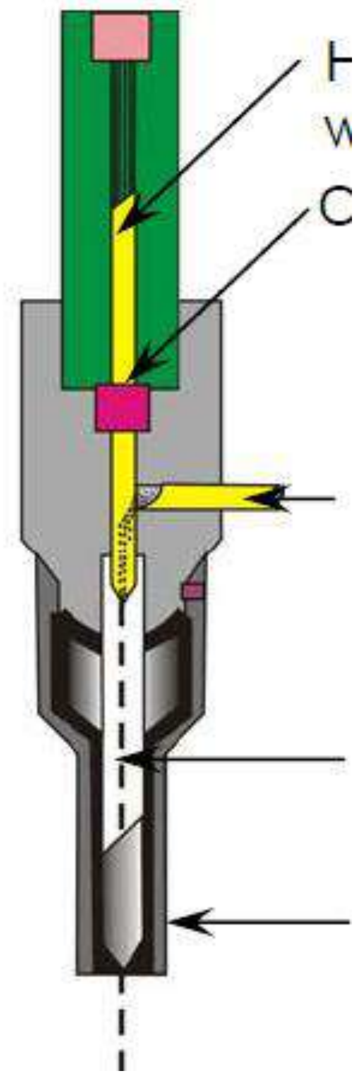
- WJM - Pure
- WJM - with stabilizer

- AWJM – entrained – three phase – abrasive, water and air
- AWJM – suspended – two phase – abrasive and water
  - o Direct pumping
  - o Indirect pumping
  - o Bypass pumping



General Experimental conditions

Orifice – Sapphires – 0.1 to 0.3 mm
Focussing Tube – WC – 0.8 to 2.4 mm
Pressure – 2500 to 4000 bar
Abrasive – garnet and olivine - #125 to #60
Abrasive flow - 0.1 to 1.0 Kg/min
Stand off distance – 1 to 2 mm
Machine Impact Angle – 60^{o} to 90^{0}
Traverse Speed – 100 mm/min to 5 m/min
Depth of Cut – 1 mm to 250 mm



Water Jet and Abrasive Water Jet Machining

Water Jet and Abrasive Water Jet Machining

Advantages of AWJM

- Extremely fast set-up and programming
- Very little fixturing for most parts
- Machine virtually any 2D shape on any material
- Very low side forces during the machining
- Almost no heat generated on the part
- Machine thick plates

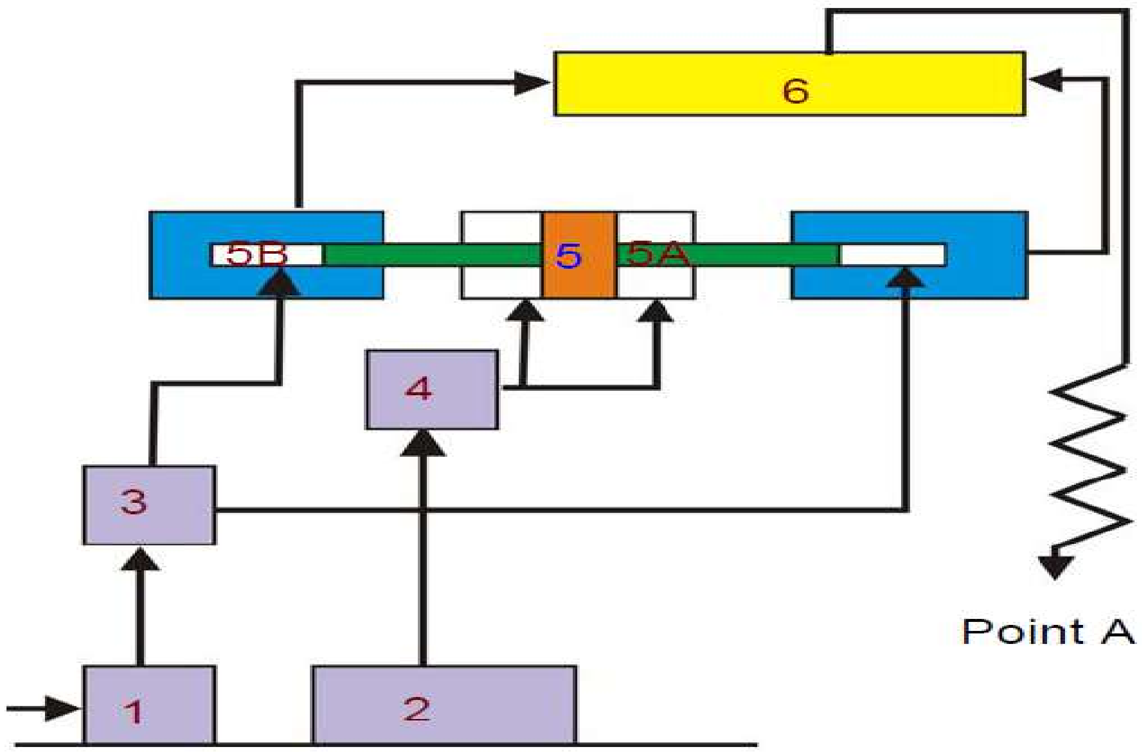
Components of AWJM

1. **LP Booster**
2. **Hydraulic drive**
3. **Additive mixer**
4. **Direction control**
5. **Intensifier**

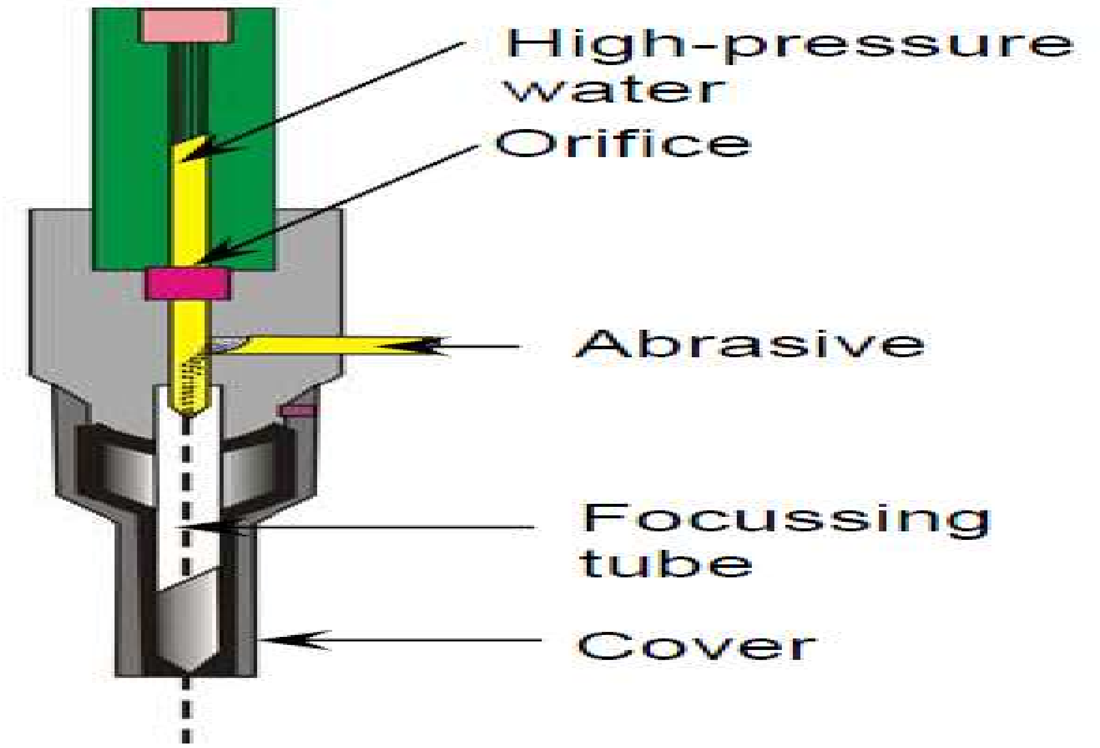
5A. LP Intensifier

5B. HP Intensifier

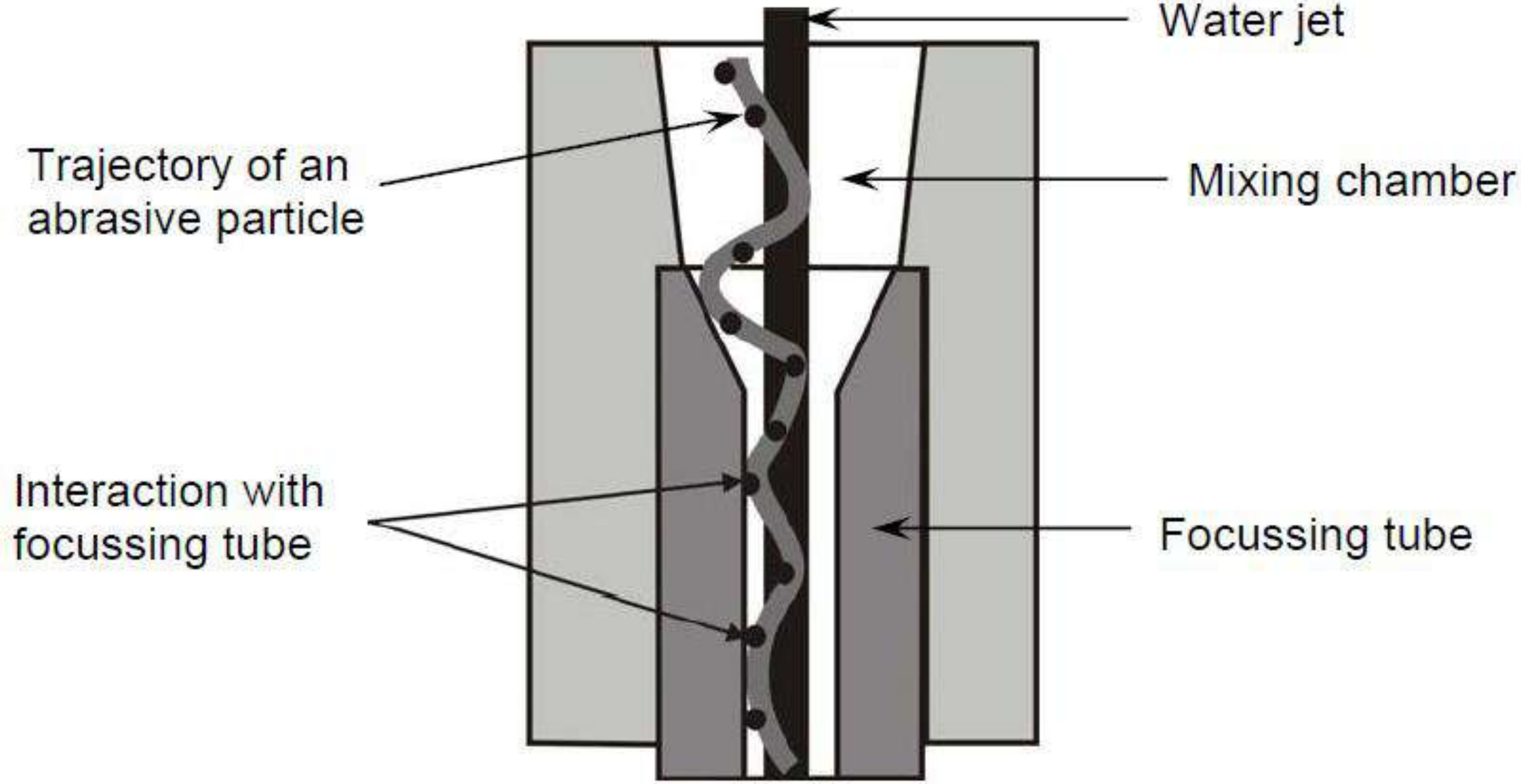
6. **Accumulator**



Components of AWJM

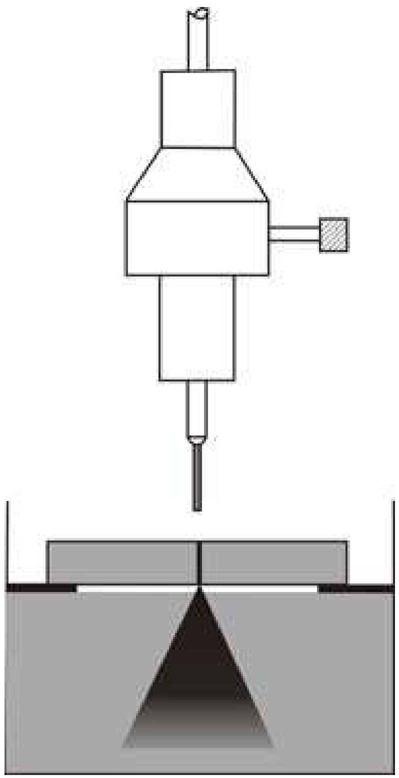


Components of AWJM

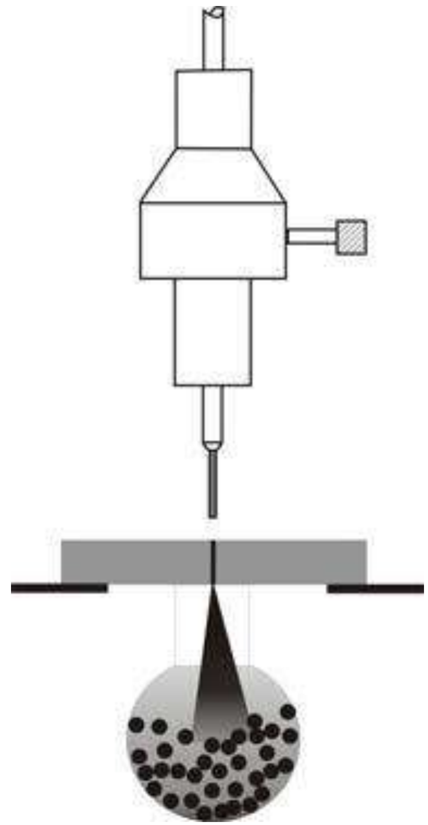


Components of AWJM

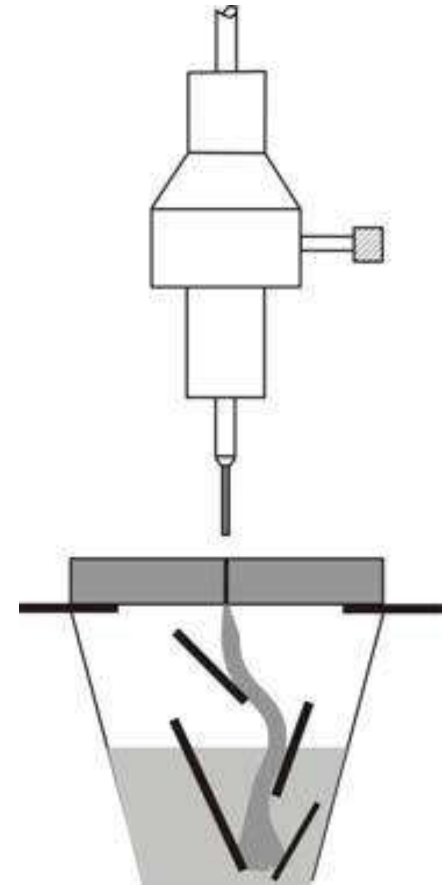
Catcher



(a) water basin

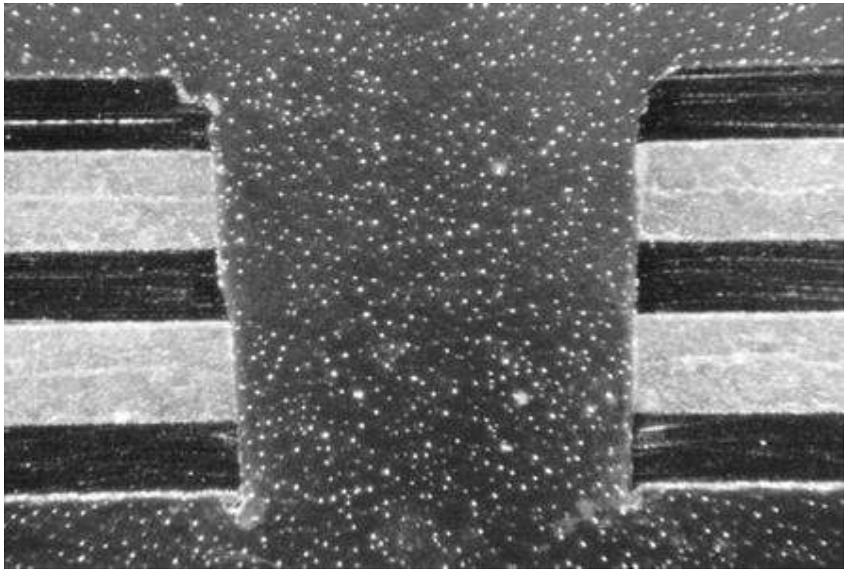


(b) steel/WC/ceramic balls

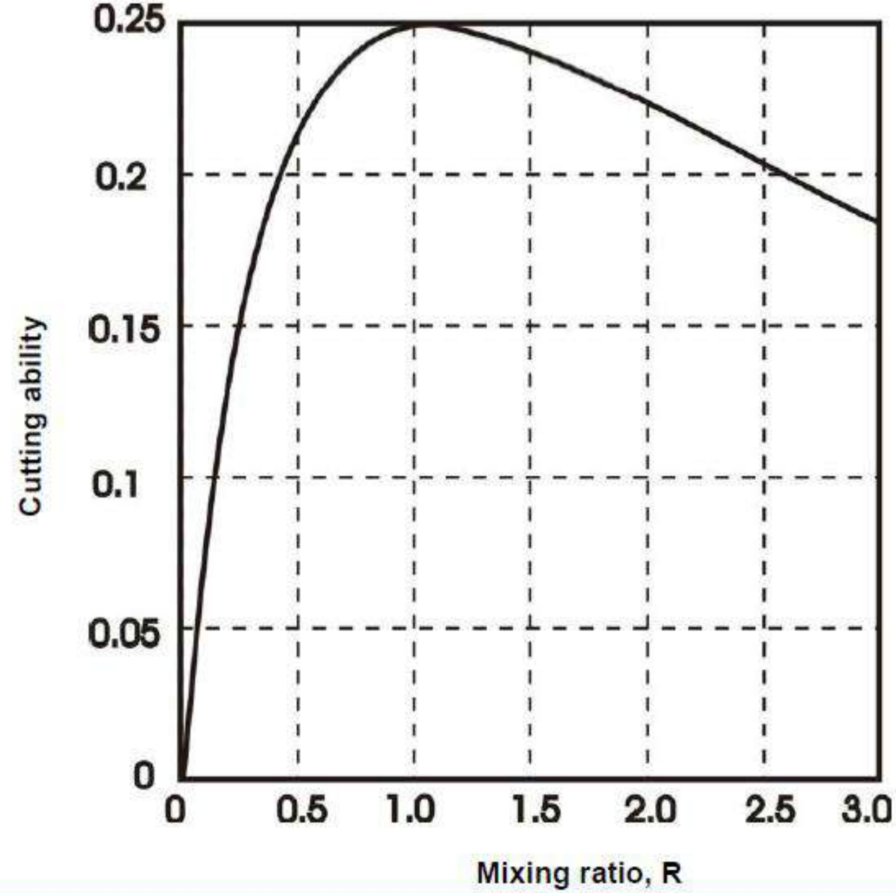


(c) catcher plates (TiB_2)

Modelling



Photographic view of kerf (cross section)

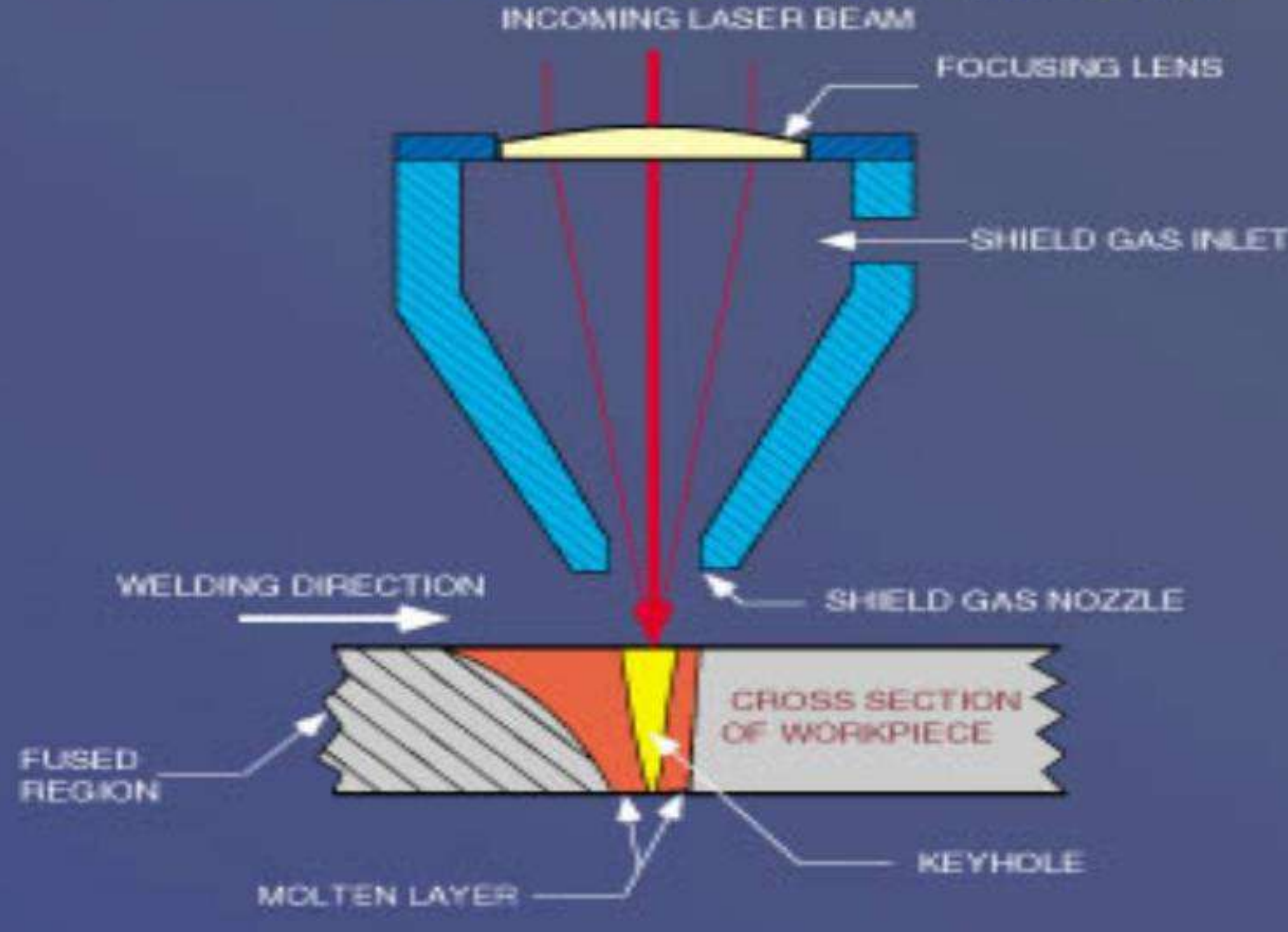


0.25
0.2
0.15
0.1
0.05
0
Cutting ability
0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio, R

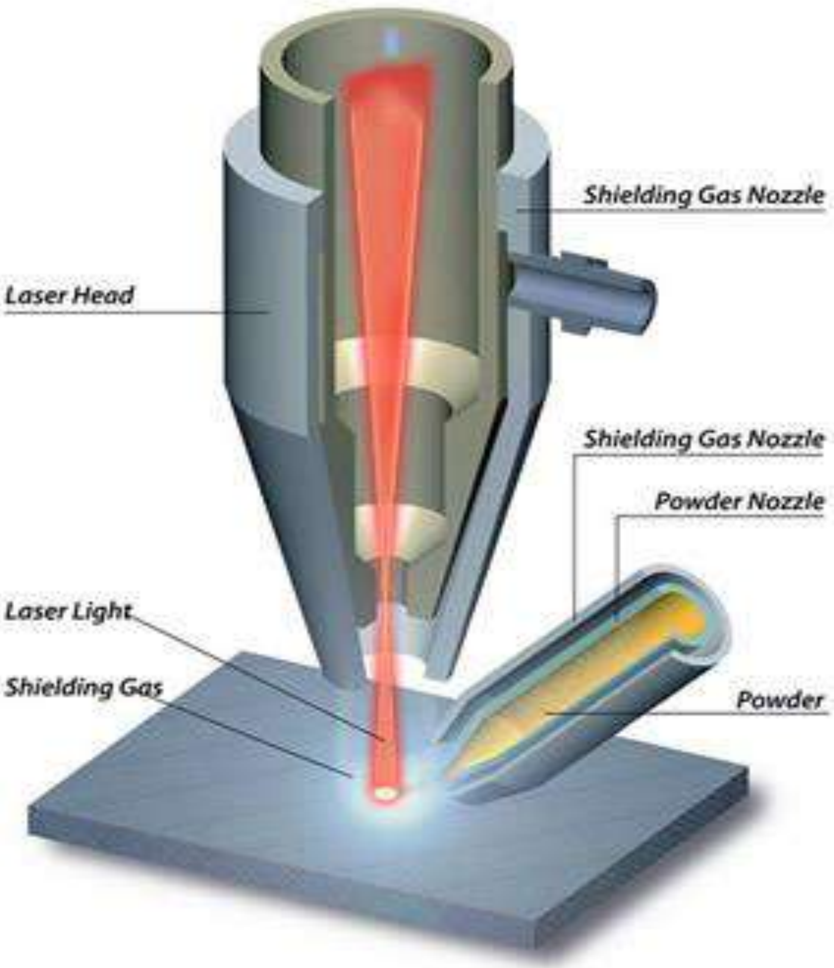
Laser Beam Welding

- *LIGHT AMPLIFICATION by STIMULATED EMISSION of RADIATION.*
- Coalescence of heat is produced by the Laser beam which is having high energy.
- Concentrated heat source.
- Allowing for narrow, deep welds.
- High welding rates.
- Frequently used in high volume applications.

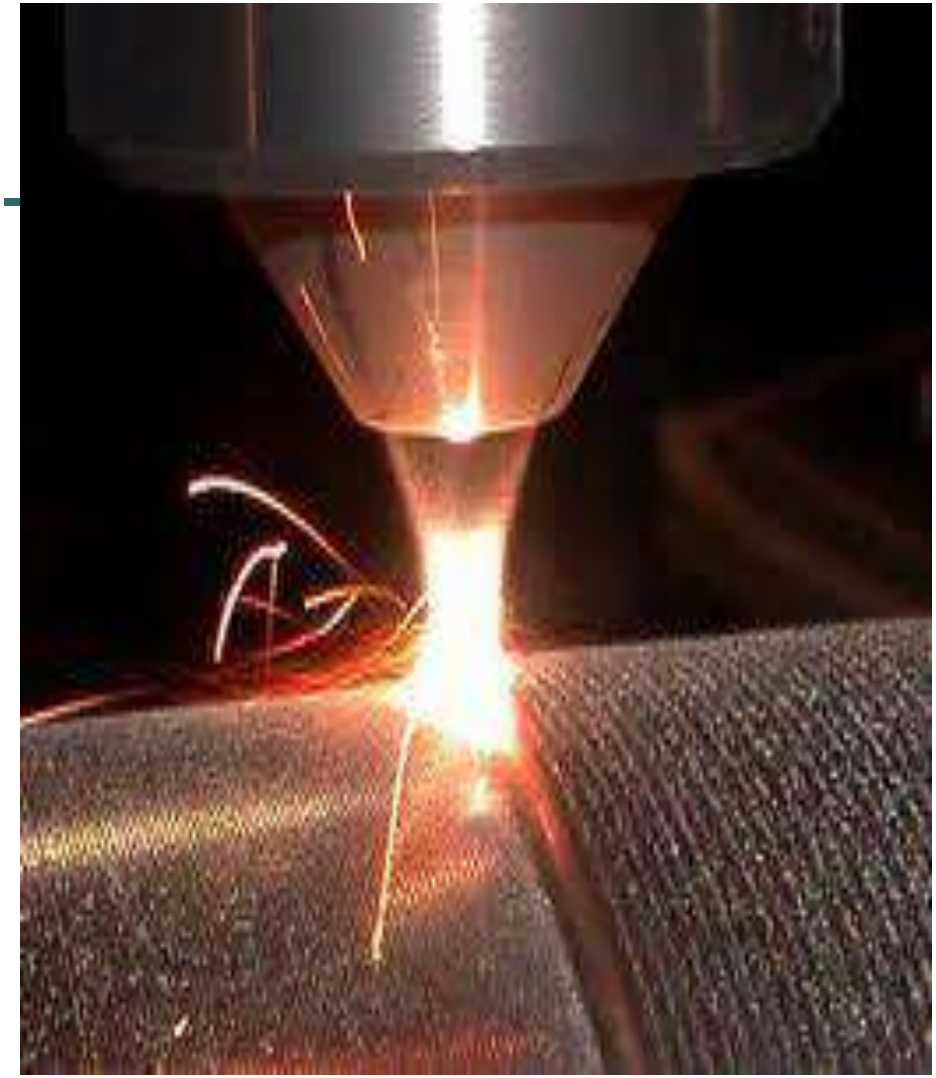
Laser welding configuration



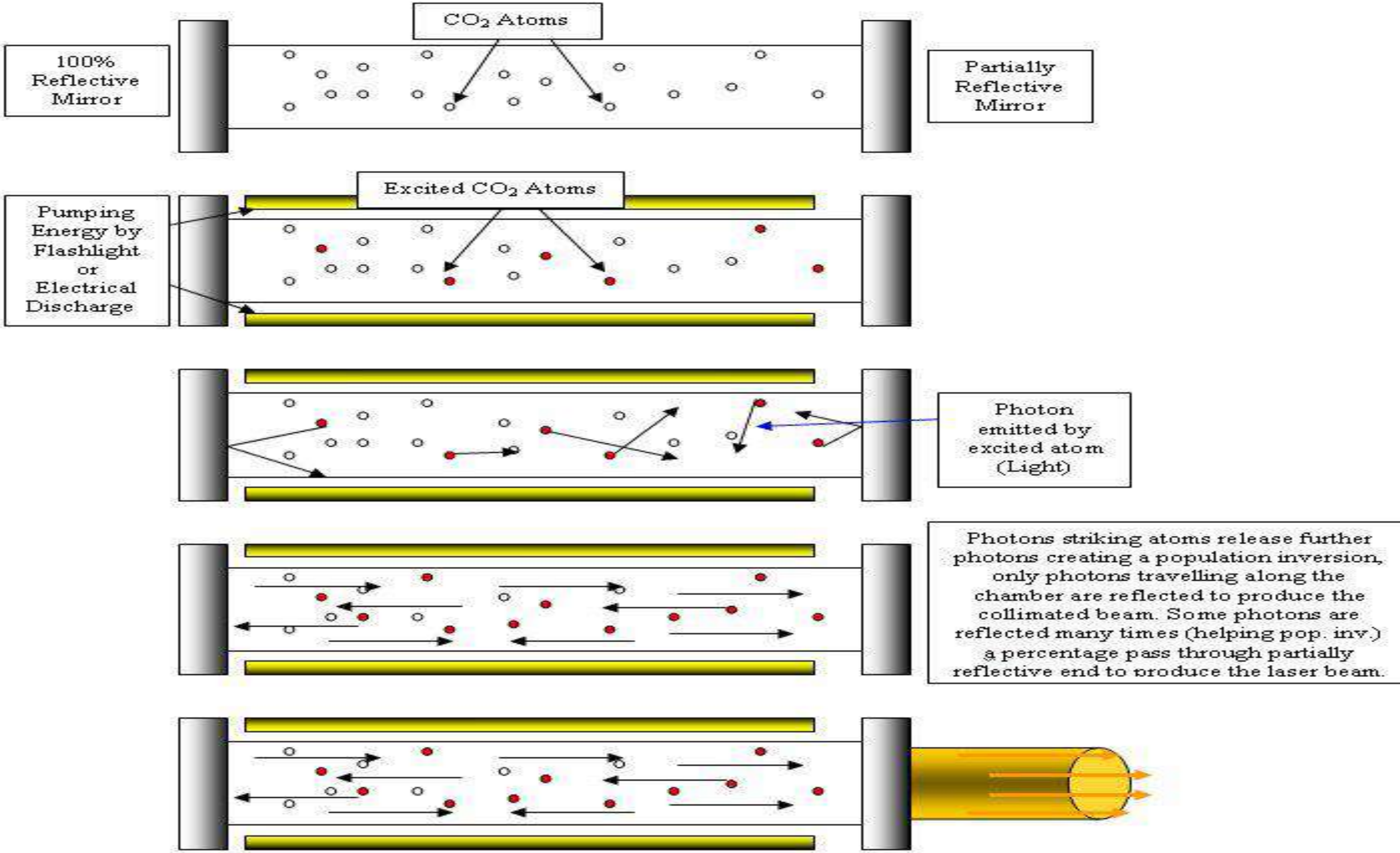
- High power density (1 Mw/cm^2)) resulting in small HAZ and high heating and cooling rates.
- The spot size vary (0.2 mm and 13 mm), though only smaller sizes are used for welding.
- The penetration is proportional to power supplied & focal point.
- Maximum penetration when focal point is slightly below the surface
- Milliseconds long pulses are used to weld thin materials such as razor blades.
- Continuous laser systems are employed for deep welds.
- High power capability of gas laser make it suitable for high volume applications.

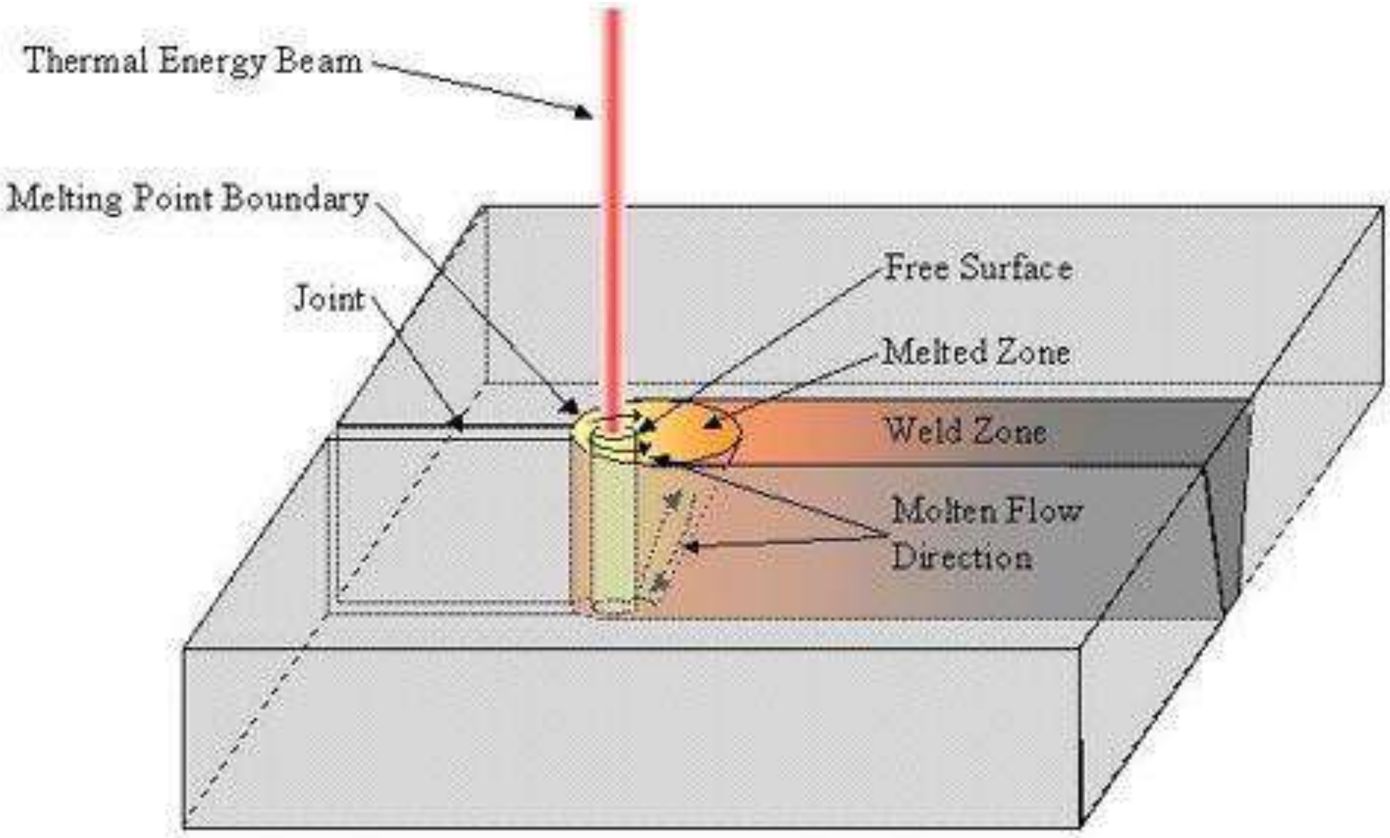


(Picture: non-coaxial powder feed)

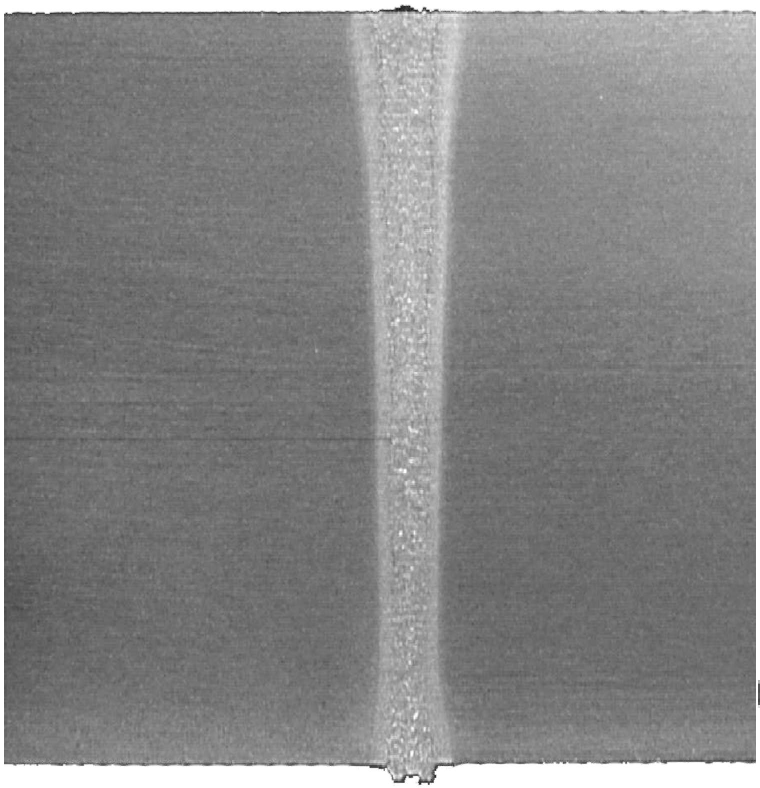


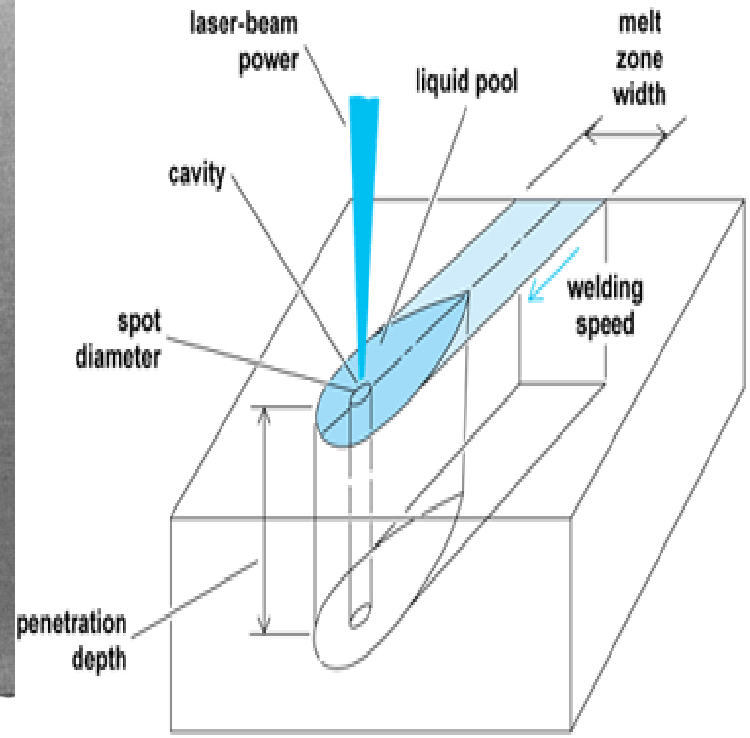
Laser Generation




Thermal Energy Beam
Melting Point Boundary
Joint
Free Surface
Melted Zone
Weld Zone
Molten Flow
Direction

Typical Work piece





(a)

(b)

Laser Hybrid Welding

- Combines LBW with an arc welding.
- It allows for greater positioning flexibility.
- Arc supplies molten metal to fill the joint, and due to the use of a laser, increases the welding speed .
- Weld quality tends to be higher as well as potential for undercutting is reduced.

Solid Laser

- Operate at wavelengths of order 1 μm, hence special protection to prevent Retina damage.
- Pulsed Laser- Ruby Laser, Neodymium Glass
- Continuous Laser- Neodymium Yttrium Aluminum Garnet (Nd YAG)
- Pulse Duration- 1/1,000,000,000 second - 2 milliseconds
- Efficiency= 1-10 %

Solid Laser cont……

- Power output:-
  - Ruby lasers = 10-20 W
  - Nd:YAG laser = 0.04-6,000 W
- Fiber optics is used.
- Popular design is a single crystal rod of 20 mm diameter and 200 mm long, ground flat ends.
- Disk shaped crystals are growing in popularity
- flashlamps are giving way to diodes due to their high efficiency

Gas Laser

- Uses high-voltage, low-current power sources.
- Both continuous and pulsed mode.
- Wavelength of the laser beam is of order 10.6 µm.
- Fiber optics absorbs these wavelength & get destroyed.
- Rigid lens and mirror delivery system is used.
- Power outputs for gas lasers can be much higher than solid-state lasers, reaching 25 kw.

Gas Laser cont…..

- CO_2 + He +N2$_2$ in glass tube
- N_2 acts as intermediary between electrical & vibration energy.
- He cools for re excitation.
- Efficiency= 20%

Specification

- Energy density= 10 ^ 6 w/ mm^2
- Power= 20 kw (1000w/ mm3 /min)
- Wavelength= 1-10 micron
- Weld thickness= upto 25mm (keyhole)
- Welding speed- 25-250 mm/min

Advantage

- Five axis laser control
- Excellent performance
- Processes high alloyed metals.
- Open atmospheric operation
- Narrow HAZ
- Low thermal inputs.
- No filler/flux is needed
- Easily welds dissimilar metals
- Extreme precise operation

Advantage cont…..

- Low weld distortion.
- Fast in terms of cost effictive
- Very small welding spot
- Weld inside transparent media like glass etc.
- Permits welding of small & closly spaced components of few micron size
- Welds electric insulators.
- Can be easily focused to microscopic dimension.
- visibility

Disadvantage

- Rapid cooling rates may cause cracking
- High capital cost
- Optical surface easily damaged
- High maintenance & setup cost
- Controlled process to limit its adverse effects
- Low welding speed
- Limited to depth of 1.5 mm without defects like blow holes & porosity.

Applications

- Electronic, Automotive & food processing
- Spot welds
- Vacuum components are welded easily
- Medical equipment
- Carbon steels & ferrous materials are welded
- Ideal for automation & robotics
- Used to weld IC to plates
- In aircraft industry to weld light gauge marerials
- Cu, Ni, Al, Ss, W, Ti, Zr, Ta Colunium etc
- Wire to wire, sheet to sheet, tube to sheet & small diameter stud welds.

Influence of explosion welding technology parameters on the titanium structure

EXPLOSIVE WELDING OF LARGE-SIZE TITANIUM–STEEL SHEETS: INFLUENCE OF AMBIENT GAS

A. A. Berdychenko, L. B. Pervukhin, and O. L. Pervukhina

TUBULAR ITEMS EXPLOCLAD WITH Ti

O. L. Pervukhina, I.V.Saikov and L. B. Pervukhin

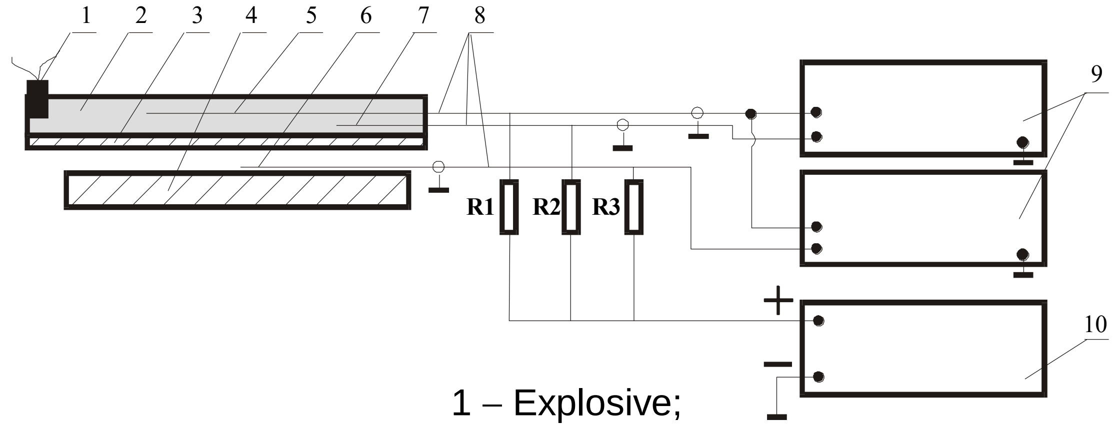
2010

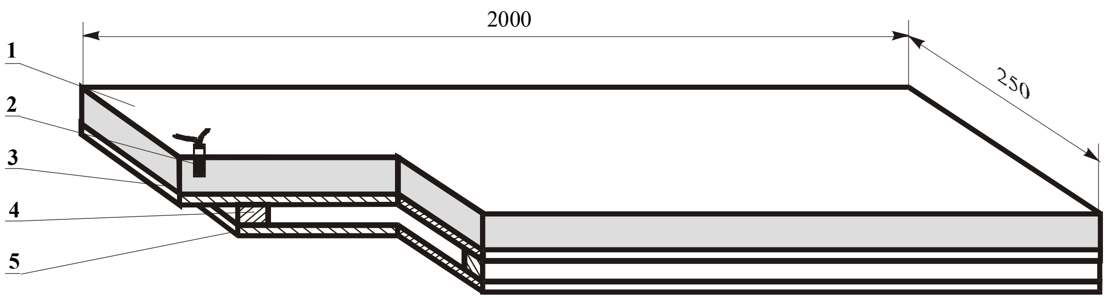
Report plan

1. Influence of ambient gas in technological gap on the titanium structure.
2. Features titanium structure at its volume deformation defined by the size of welding gap.

Research technique

1 – electric detonator;
2 – explosive; 3 – clad plate ;
4 – base plate ; 5 – starting sensor; 6 – shutdown sensor of the fist frequency meter;
7 – shutdown sensor of the second frequency meter;
8 – connecting cables;
9 – frequency meters;
10 – power supply





1 – Explosive;

2 – electric detonator;

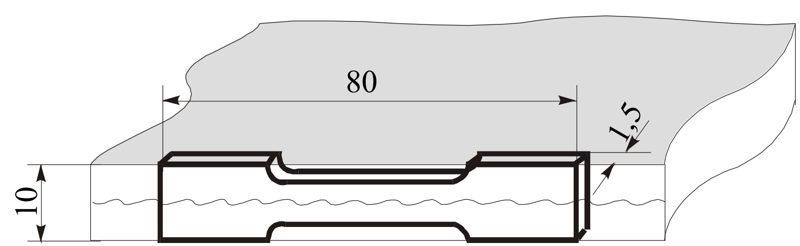
3 – titanium clad plate, thickness is 5 mm;

4 – titanium bar, thickness is 5 mm;

5 – titanium base plate, thickness is 5 mm.

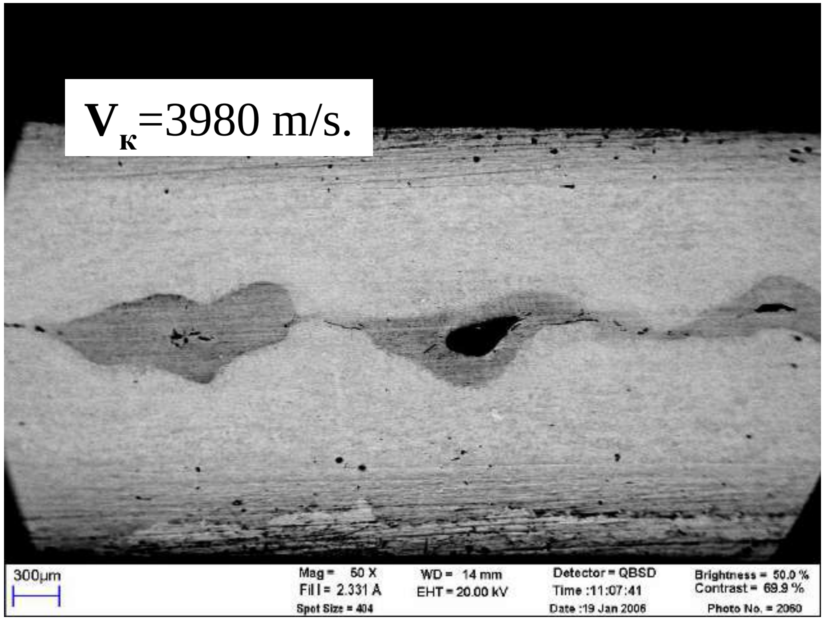
Research methods

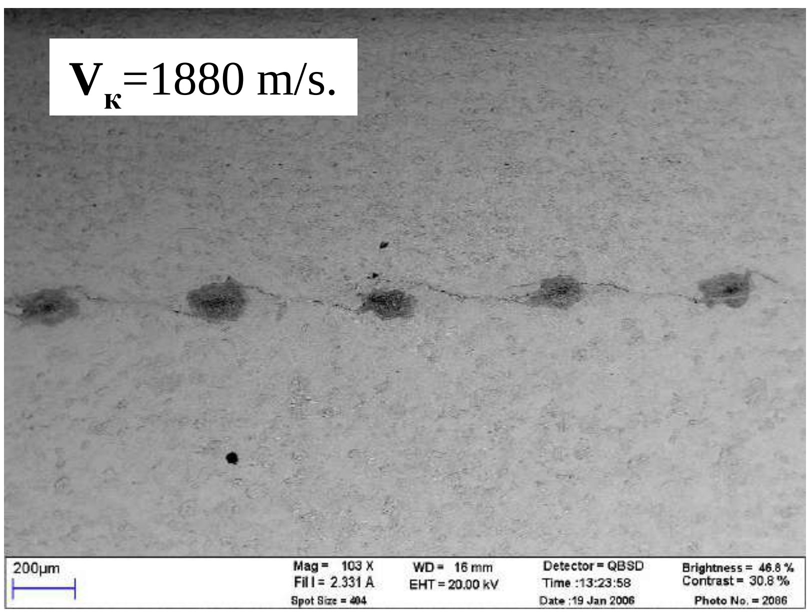
TEM, X-ray, laser mass-spectograph

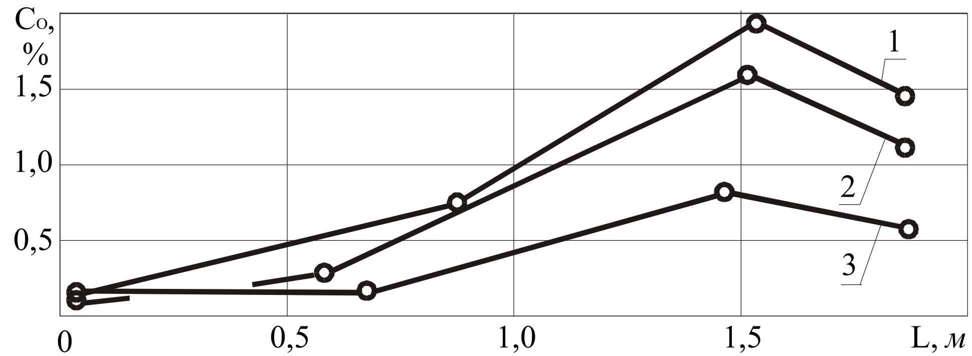


Air D=3940 - 1880 m/s

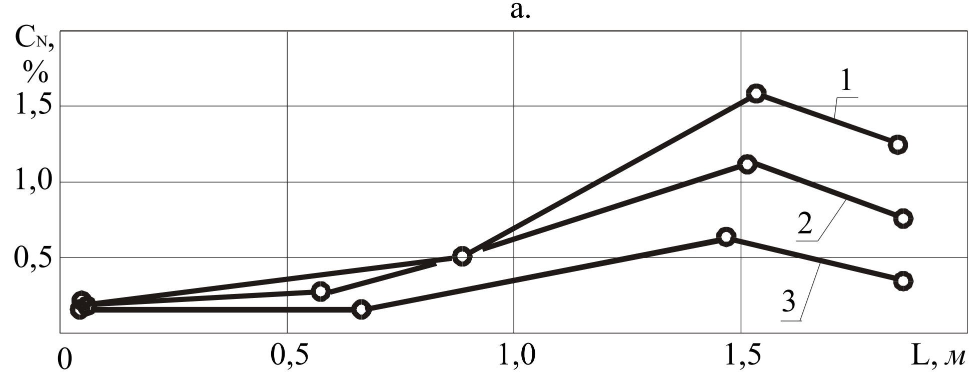
Change of concentration of oxygen $\mathbf{C_O}$ (a) и nitrogen $\mathbf{C_N}$ (б) in metal of vortical zones







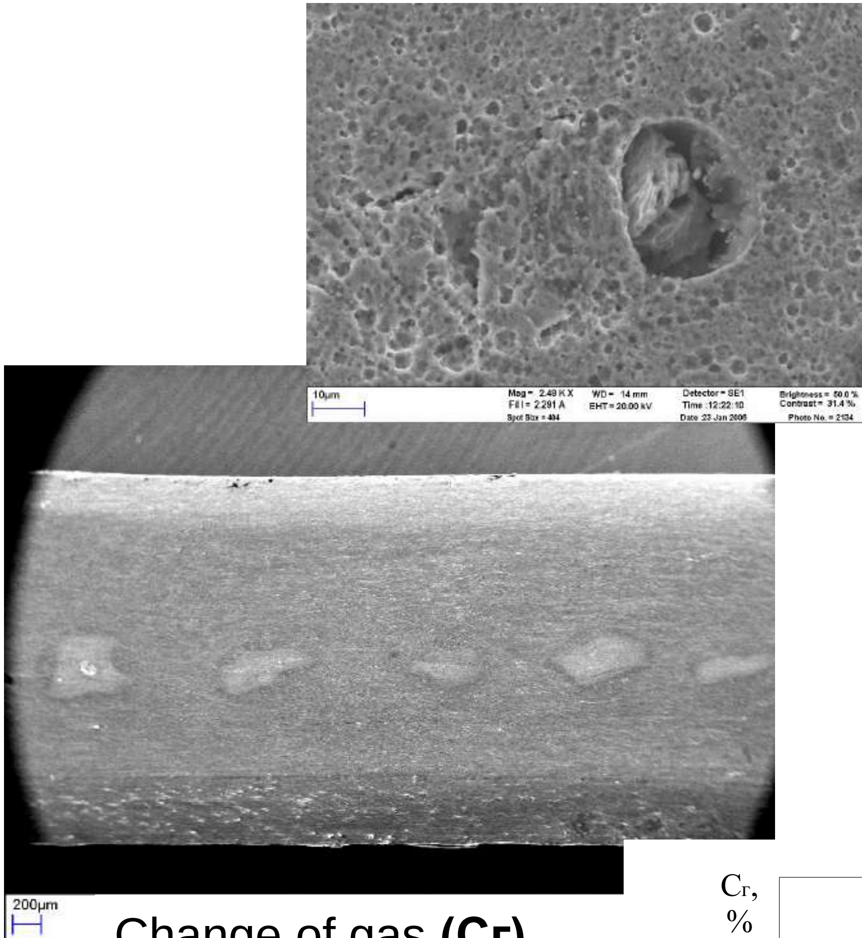
а.

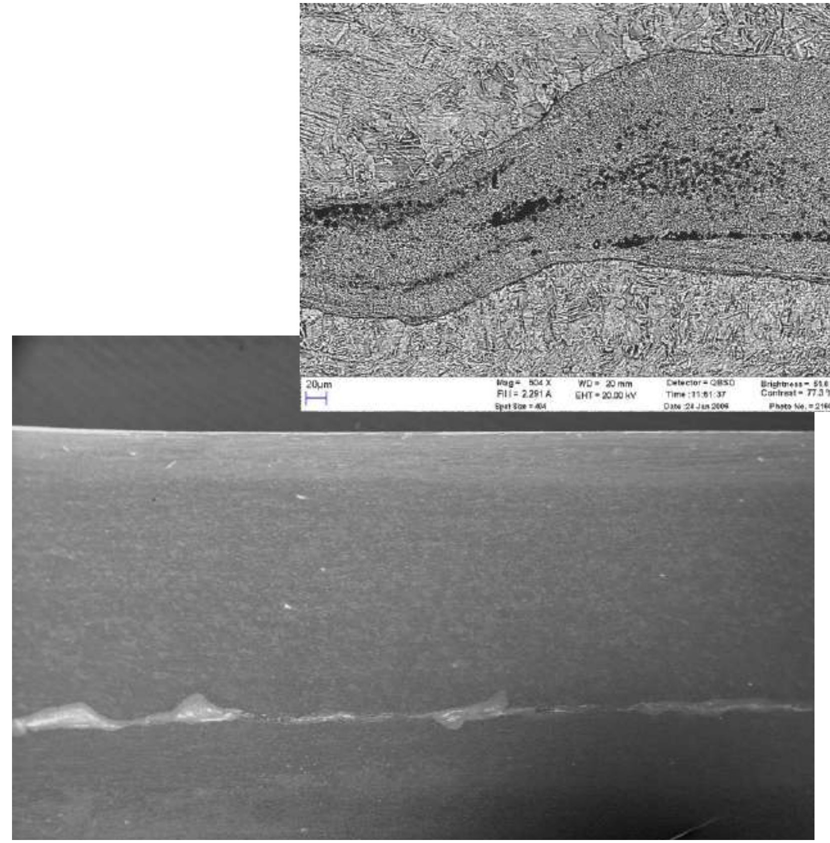


б.

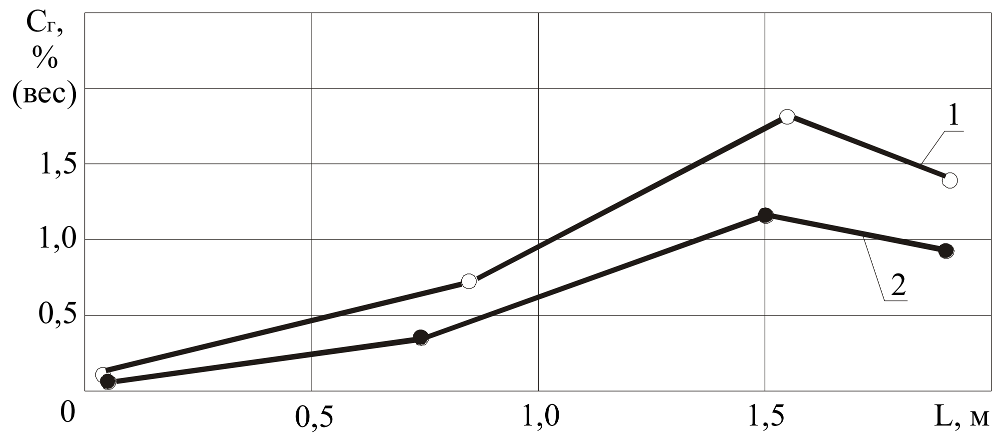
1 – $\mathbf{V_к}$=3980 m/s; 2 – $\mathbf{V_к}$=2640 m/s; 3 – $\mathbf{V_к}$=1880 m/s.

D=2690 м/с Nitrogen Oxygen



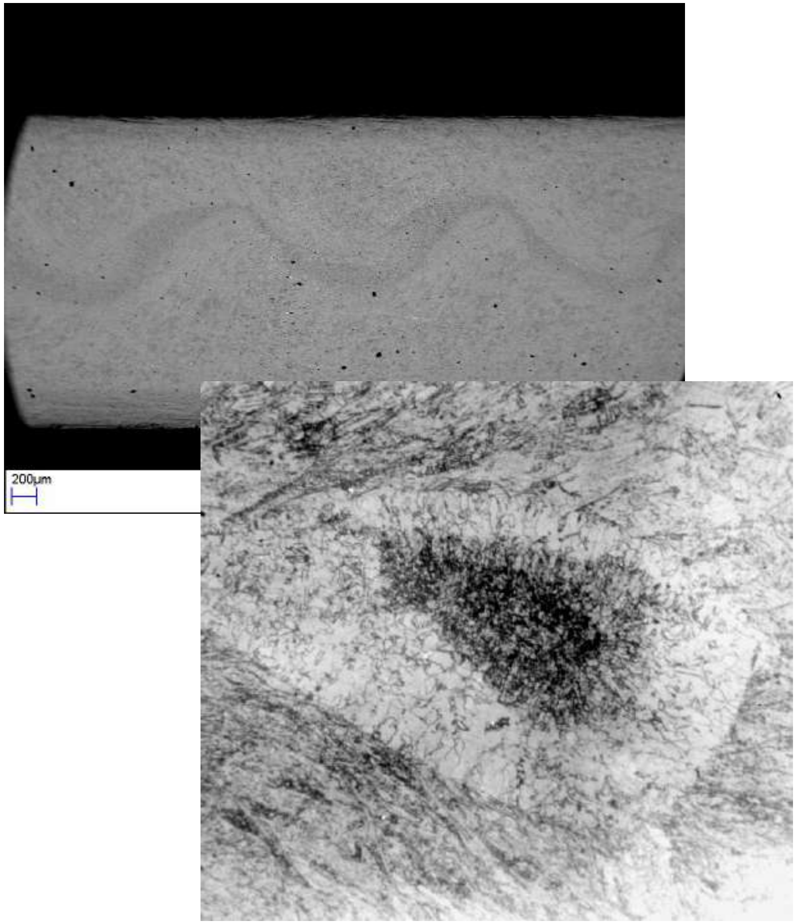


Change of gas **(Cг)** concentration in a material of vortical zones of welded connections received in the environment of oxygen (1) and nitrogen (2)

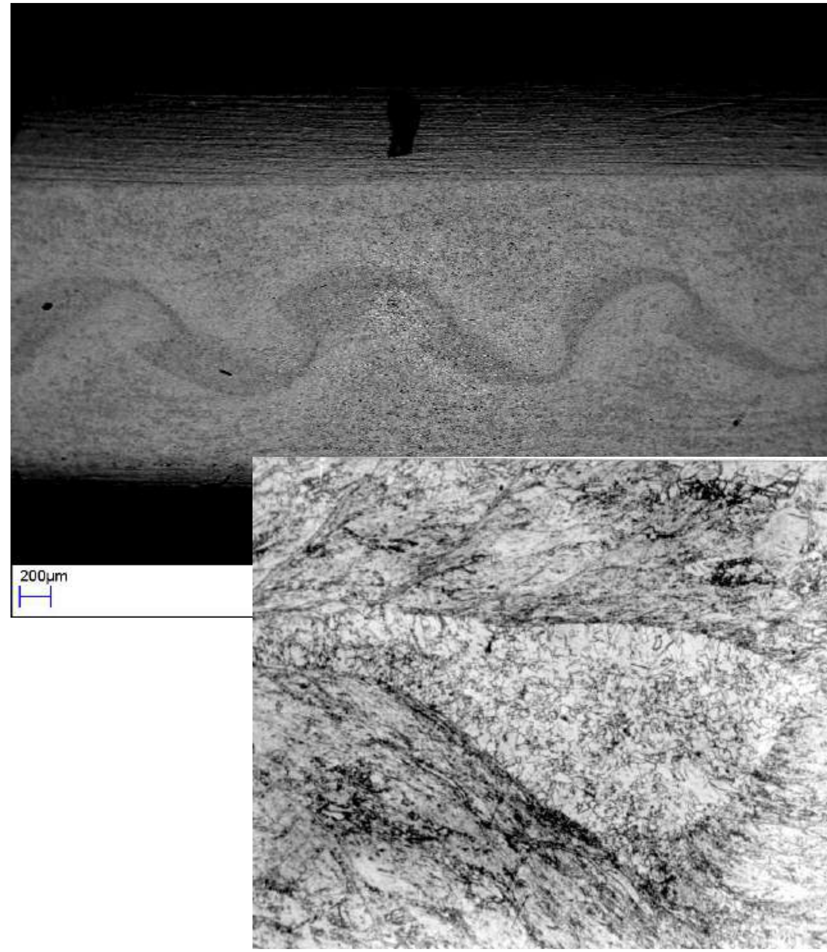


D=2690 м/с

Argon



Helium



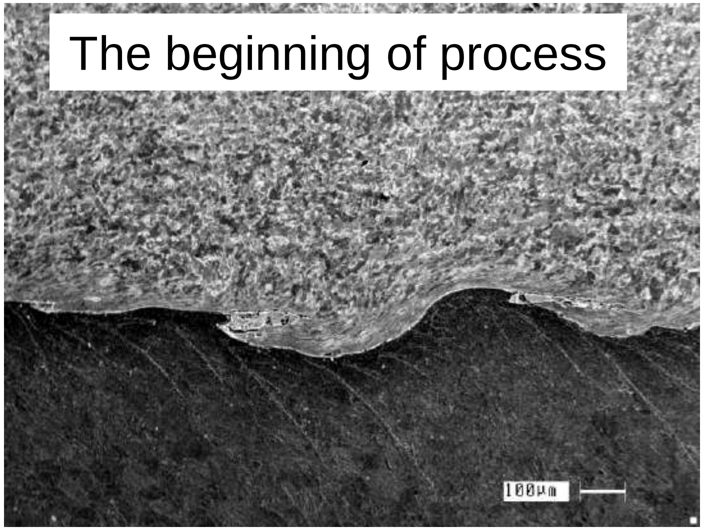
Welding in the environment of inert gases of argon and helium considerably improves structure of welded joint, raises its plasticity and stabilizes quality of welded joint along the full area regardless of its sizes. The best quality and stability of properties provides with filling of technological gap with helium.

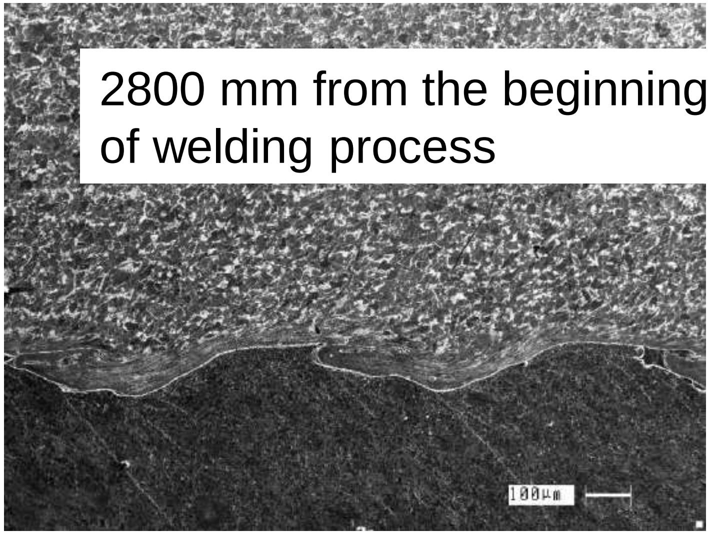
Ti+Steel

The technology of large-size two-layer sheets (Steel + Titanium) manufacture by explosion welding was developed and patented. The technical conditions “Two-layer intermediates Steel+Titanium produced by explosion welding” were formalized and conformed to Gosatomnadzor. Trumpet lattices of condensers are produced from two-layer clad in OAO «Kaluga turbine factory ».

Ti+Steel

Microstructure Steel 10 + Titanium BT1-0 welded by explosion in argon atmosphere.





Grade of bimetal, sizes, mm	Durability of joint, MPa		Tests, degree	
	Tearing off	Shear	Bend	Lateral bend
09Г2С+BT1-0 35(30+5)x1000x2000	390-490	155-215	130-135	130-135
12Х18Н10Т+BT1-0 55(50+5)x110Х1750	305-335	180-350	130-135	130-135
20+BT1-0 38(30+8)x2700x2900	250-350	190-250	More 80	More 80
20+BT1-0 48(40+8)x1800x3500	250-350	190-250	More 80	More 80

Problems at manufacture of long-length cylindrical copper - titanium details by explosion welding :

1. Instability of process at length over 250 mm
2. Occurrence of cracks in clad layer;
3. Formation of intermetallic phases and titanium into a joint zone.

Choice of technological gap size :

- Thermodynamic conditions of qualitative joint formation (temperature, pressure, time) must be provided.

- It is necessary to exclude conditions of deformation localization in the titanium and cracks formation.

- It is necessary to take into account the possible fluctuation of technological gap in the limits with length of units.

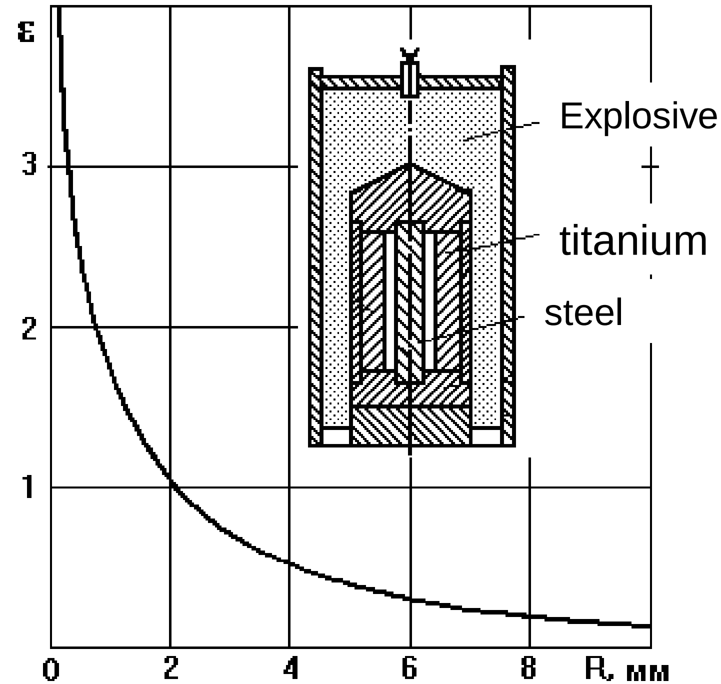
Deformation features of a titanium pipe at explosive compression

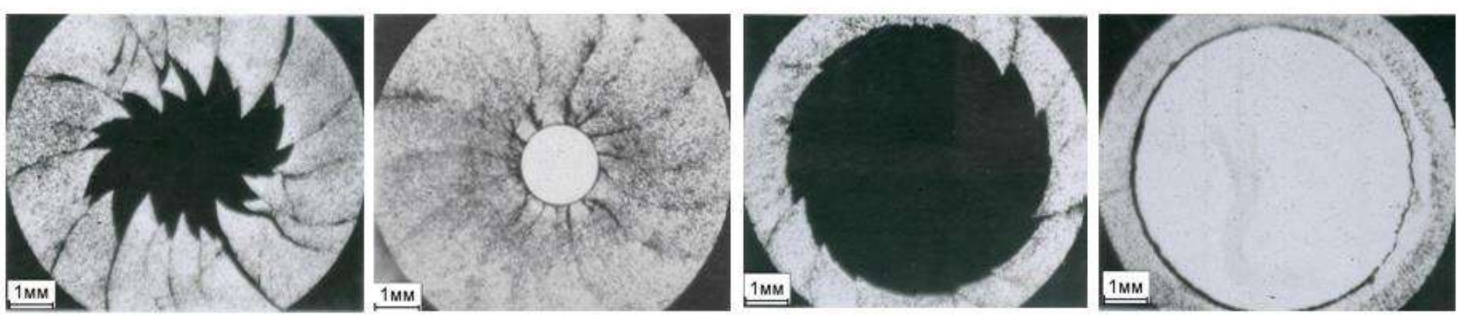
Experiments spent on cylinders from titanium pipe with the size of grain 25 microns.

Length of 70 mm,

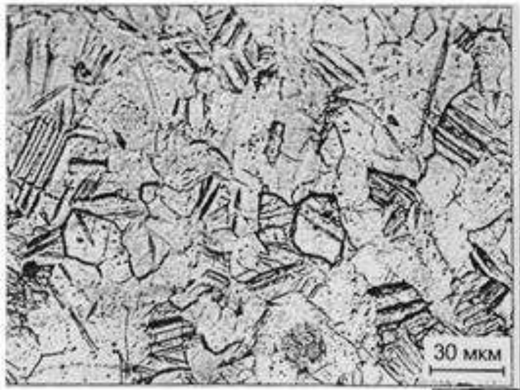
external ∅ 20 mm, internal ∅ 11 mm

$$\varepsilon_r = \frac{R_0}{R} - 1$$

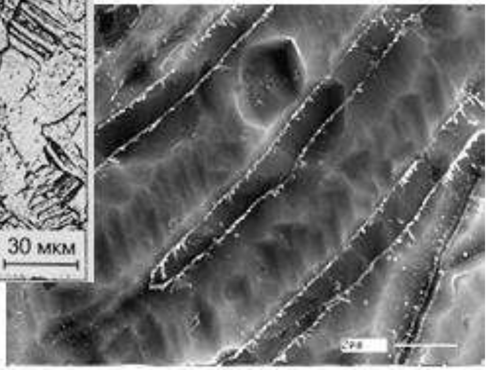


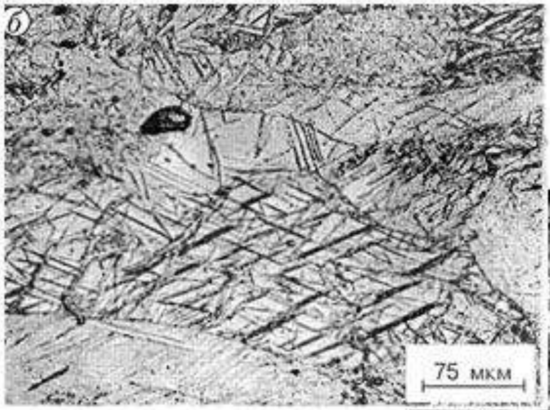


Titanium microstructure at different deformations after shock-wave loading.

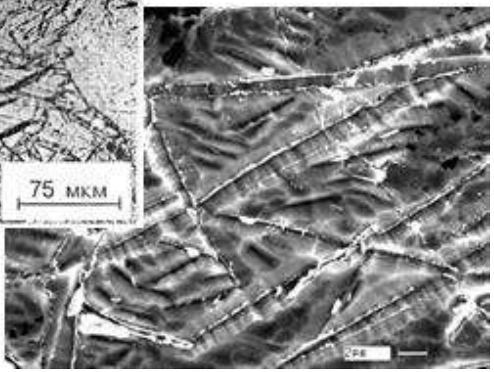


d=25мкм





d=140мкм



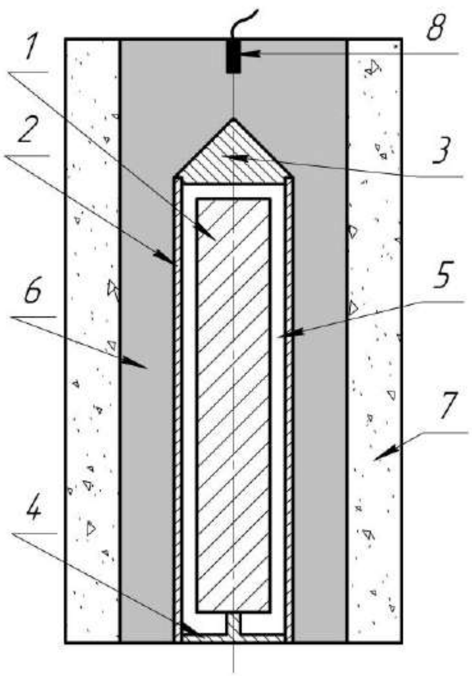
Development of a localization strip

The size of grain	Critical parameter of localization
140 мкм	ε - 0,59
40 мкм	ε - 0,36
25 мкм	ε - 0,22

Clad long-length copper bars by a titanium pipe

1. To except cracks formation in Ti the size of technological gap should provide the relative volumetric cylinder deformation no more than 0,22.

2. To quench a deformation localization in Ti it is necessary to provide heating of the surface layer to the temperature of plastic state.



1- Copper core
2 - titanium pipe
3 - The top cover
4 - The bottom cover
5 - Technological gap
6 - Explosive
7 - Sand
8 - Detonator

3. To save the thermodynamic conditions of explosion welding it is necessary to except titanium burning in a gap by means of its filling with inert gas.

Titanium deformation on the end sites of intermediates

ε_r=0.6.

Change of deformation mechanism of titanium during explosive loading is revealed

ε_r=0.6.

Intermediate Ti+Cu for a contact jaw

Copper bar

∅ 25 mm,
l = 1000 mm

Titanium pipe

wall thickness is 2.5 mm

The relation of length to diameter = 33

ε_r=0.1

Conclusion:

The experimental technology of long-length Ti+Cu bars manufacture by explosion welding providing 100% joint continuity and necessary electrical resistance of joint zone was developed under the research of deformation features of titanium pipe and influence of ambient gas in the welding gap.

NON CONVENTIONAL MANUFACTURING

Engineering Materials

- Metals & Alloys
- Plastics & composites
- Ceramics

How to machine them ?

↓ Solution

Non conventional Manufacturing or Advance Machining Process.

Now a days demand trends in industries like –
(Aerospace, Missiles, Automobiles, Nuclear Reactions, etc.)

↓

Engg materials having Much superior properties.

- → ultra high strength, Hardness
- → very high temperature resistance
- → Difficult to machine by conventional Machining methods.

For This → Workpiece material hardness >> tool material hardness.

How to solve the problem

↓

Non Conventional Manufacturing process
or
Advance machining process

Because

↓

Workpiece hardness does not Matter in Non conv. mfg.

Why do you need advanced Machining Process or Non. conv. Mfg. ?

Because of →

- **Limitations of Conventional Machining Process**

(Workpiece hardness, surface roughness, 3-D parts, complex geometries, Residual stress, Burrs, unwanted distortion, etc.)

- increased workpiece hardness → ↓ cutting speed → ↓ Productivity → ↓ Economic
- Rapid improvement in the properties of materials (workpiece → strength, hardness, etc.)
- Metal & non metals :- Stainless steel, High strength temperature resistance, super alloy etc
- Tool material hardness >> workpiece hardness
- Require much superior quality of tool materials

* Note (ceramics)

Al_2O_3	9
SiC	9
ZrO_2	8
WC	8.5
Mild steel	5
Aluminium	3
HSS	7
Glass	6
Plastic	3.5

Why do we need Non Conv. mfg. ?

Product requirement

- Complex shapes.
- Machining in inaccessible areas
- Low tolerance (~ 10 μm)
- Better surface integrity (no surface defects etc)
- High surface finish (nano level.)
- High MRR.

Why do you need Non conv. Mfg?

→ High Production rate while processing difficult to machine materials.

→ Low cost of production

→ Precision and ultraprecision machining.
(Nanometer Machining)

↓

Requires material removal in the form of atoms and or molecules.

↓

Advanced Mfg Process/ Non Conv. mfg.

Classification based on the Kind of Energy used: Mechanical, Thermoelectric, Electrochemical or chemical:

Mechanical	Thermoelectric	Electrochemical & chemical.
✓ Abrasive jet M/c (AJM)	✓ Laser Beam M/c (LBM)	✓ Electro chemical M/c (EC
✓ Ultrasonic M/c (USM)	✓ Electron Beam M/c (EBM)	• (Chemical M/c (CHM)
✓ Water jet M/c (WJM)	✓ Electric Discharge M/c (EDM)	
✓ Abrasive water jet M/c (AWJM)	• (Plasma arc M/c (PAM))	
	• (Ion Beam M/c (IBM))	

Name of Faculty: - Santosh Kumar Branch:-Mechanical		
Course Code:- ME-021x17		
Date of exam:-21/04/2018		
Test Type:- Mid Sem		
Test Abbrevation: SESSIONAL TEST		
Maximum Marks		30
Test Topic:-Non Convetnional Manufacturing		
S. No.	Registration NO.	Marks
1	15102107066	24
2	15102107067	30
3	15102107068	21
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5	15102107070	23
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