

注意：考試開始鈴響前，不得翻閱試題，  
並不得書寫、畫記、作答。

國立清華大學 111 學年度碩士班考試入學試題

系所班組別：動力機械工程學系  
丁組(設計、製造組)

科目代碼：1402

考試科目：科技英文

### —作答注意事項—

1. 請核對答案卷(卡)上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清(含未依範例畫記)致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「國立清華大學試場規則及違規處理辦法」，無法因本試題封面作答注意事項中未列明而稱未知悉。

# 國立清華大學 111 學年度碩士班考試入學試題

系所班組別：動力機械工程學系碩士班 丁組(設計、製造組)

考試科目 (代碼)：科技英文(1402)

共 8 頁，第 1 頁 \*請在【答案卷、卡】作答

Time: 10:30~12:10 (100 minutes)

Question I, problem 1-30, 2 points for each question.

Question II, problem 31-35, 2 points for each question.

Question III, Problem 36-45, 3 points for each question.

No points will be deducted for incorrect answers.

## Questions I (2 points each)

Choose the best answer to replace the section in the question that has an underline.

1. A microscope makes a small thing appear much larger than \_\_\_\_\_.  
(A) really are, (B) are really, (C) they really are, (D) are they really, (E) that they really
2. Fruits and vegetables are a good source \_\_\_\_\_ vitamins and minerals.  
(A) in, (B) of, (C) have, (D) that, (E) what
3. A research institute offers staffs \_\_\_\_\_ which include a pension plan.  
(A) benefits, (B) benefitting, (C) benefitted, (D) beneficial, (E) beneficially
4. She could not sit in an aisle seat during her bus trip because there were \_\_\_\_\_ available.  
(A) some, (B) any, (C) mainly, (D) none, (E) more
5. Transport officials were unsure of \_\_\_\_\_ caused the airplane crash in this night.  
(A) why, (B) what, (C) where, (D) those, (E) each
6. The guide told visitors that the machine \_\_\_\_\_ by the famous engineers.  
(A) design, (B) designs, (C) designing, (D) designed, (E) was designed
7. They \_\_\_\_\_ to fill in the forms for agreements.  
(A) remind, (B) have reminded, (C) reminding, (D) are reminding, (E) are reminded
8. Researchers looking for good papers will find a \_\_\_\_\_ selection in the special issues.  
(A) greater, (B) greatest, (C) greatly, (D) more greatly, (E) greaten
9. \_\_\_\_\_ students had to attend the class for the training without exception.  
(A) All, (B) Every, (C) A lot, (D) One, (E) No
10. He had to work \_\_\_\_\_ to get the report finished by the deadline.  
(A) intense, (B) intensity, (C) intensities, (D) intensive, (E) intensely
11. The open of a restaurant was successful \_\_\_\_\_, but the owner wished the event had attracted more attention from media.  
(A) only, (B) enough, (C) yet, (D) soon, (E) rather

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考試科目 (代碼)：科技英文(1402)

共 8 頁，第 2 頁 \*請在【答案卷、卡】作答

Time: 10:30~12:10 (100 minutes)

Question I, problem 1-30, 2 points for each question.

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Question III, Problem 36-45, 3 points for each question.

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12. He paused \_\_\_\_\_ during his presentation to change the slide projected on the screen.  
(A) a moment, (B) moments, (C) momentous, (D) momentarily, (E) momentary
13. Arrangement of an appointment to see Prof. Lin two weeks in advance is \_\_\_\_\_ due to his busy schedule.  
(A) precise, (B) strange, (C) grateful, (D) necessary, (E) conclusive
14. The department celebrated the \_\_\_\_\_ of its 50th anniversary by hosting a party.  
(A) gratitude, (B) birth, (C) integration, (D) impression, (E) occasion
15. Under the president leadership, corporations recovered from losses and began making substantial \_\_\_\_\_.  
(A) regulations, (B) estimations, (C) earnings, (D) losses, (E) regulations
16. Government grants for college tuition will make education \_\_\_\_\_ to more people from around the world.  
(A) plentiful, (B) painful, (C) confidential, (D) exclusive, (E) accessible
17. Job failure means being fired from a job, being asked to resign, or leaving \_\_\_\_\_ to protect yourself.  
(A) abruptly, (B) voluntarily, (C) knowingly, (D) understandably, (E) increasingly
18. The theory that as people become more independent of one another, they begin to feel so isolated and lonely that freedom becomes a \_\_\_\_\_ condition was accepted.  
(A) common, (B) permanent, (C) political, (D) positive, (E) negative
19. The cuckoo would be one of nature's more \_\_\_\_\_ creatures, blithely laying the eggs in the nests of other birds and leaving the incubating and nurturing to them.  
(A) feckless, (B) lackluster, (C) industrious, (D) domestic, (E) mettlesome

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考試科目 (代碼)：科技英文(1402)

共 8 頁，第 3 頁 \*請在【答案卷、卡】作答

Time: 10:30~12:10 (100 minutes)

Question I, problem 1-30, 2 points for each question.

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Question III, Problem 36-45, 3 points for each question.

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20. Now that the company has hired additional workers, it can \_\_\_\_\_ with the construction of the new buildings.  
(A) concern, (B) proceed, (C) step, (D) replace, (E) enhance
21. The Professor's \_\_\_\_\_ of the discussion is considered unique and daring.  
(A) calculation, (B) subtraction, (C) interpretation, (D) reason, (E) obligation
22. The chief executive officer made an official apology \_\_\_\_\_ the company for mistakes.  
(A) on behalf of, (B) called as, (C) as soon as, (D) according to, (E) in spite of
23. Members can \_\_\_\_\_ papers in open access journals even their institution does not subscribe.  
(A) access, (B) come, (C) proof, (D) intend, (E) work
24. One microampere is \_\_\_\_\_ ampere.  
(A)  $10^{-3}$ , (B)  $10^{-6}$ , (C)  $10^{-9}$ , (D)  $10^{-12}$ , (E)  $10^{-15}$
25. One cubic micrometer is \_\_\_\_\_ liter.  
(A)  $10^{-3}$ , (B)  $10^{-6}$ , (C)  $10^{-9}$ , (D)  $10^{-12}$ , (E)  $10^{-15}$
26. Multiplying the area by the height gives the \_\_\_\_\_.  
(A) length, (B) area, (C) volume, (D) power, (E) force
27. The unit of rpm is widely used to show the rotations per \_\_\_\_\_.  
(A) mind, (B) matrix, (C) minute, (D) matching, (E) mass
28. Wind turbines convert the \_\_\_\_\_ energy in the wind into mechanical power.  
(A) kinetic, (B) electric, (C) thermal, (D) optical, (E) chemical
29. Megapascal (MPa) is unit for \_\_\_\_\_.  
(A) force, (B) resistance, (C) voltage, (D) power, (E) pressure
30. Linear flow velocity in the tube which cross-sectional area is  $100 \text{ mm}^2$  and volume flow rate is  $1 \text{ mL/s}$  is \_\_\_\_\_.  
(A)  $0.01 \text{ mm/s}$ , (B)  $0.1 \text{ mm/s}$ , (C)  $1 \text{ mm/s}$ , (D)  $10 \text{ mm/s}$ , (E)  $100 \text{ mm/s}$

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考試科目 (代碼)：科技英文(1402)

共 8 頁，第 4 頁 \*請在【答案卷、卡】作答

Time: 10:30~12:10 (100 minutes)

Question I, problem 1-30, 2 points for each question.

Question II, problem 31-35, 2 points for each question.

Question III, Problem 36-45, 3 points for each question.

No points will be deducted for incorrect answers.

## Questions II (2 points each)

Try to help complete the description of microfluidics by filling the answers in.

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Miniaturized analytical systems \_\_\_31\_\_\_ as microfluidics, micro-total analysis systems ( $\mu$ -TAS), and lab-on-a-chip have attracted attention over the last 30 years. In this concept, microfluidic channels \_\_\_32\_\_\_ on a substrate and various types of chemical and biochemical processes are integrated into the channels. When compared with bulk processes, there are many advantages with such miniaturized analytical systems, such as ease of analysis, high-speed reaction, low reagent consumption, and small sample volumes. First \_\_\_33\_\_\_ all, considering their typical diffusion time, molecules diffuse over micrometer regions within the order of seconds. Therefore, molecular transport in liquids, even at liquid/liquid interfaces, gas/liquid interfaces, and solid/liquid interfaces, can be completed within a very short time. \_\_\_34\_\_\_ addition, considering the small heat capacity of liquids inside a microfluidic channel, the temperature can be instantaneously changed. Such characteristics are essential for the control of chemical reactions, and \_\_\_35\_\_\_ observed in bulk-scale chemical reactions; therefore, microfluidic devices have received much attention as chemical reaction tools.

31. (A) know, (B) knew, (C) are known, (D) known, (E) knowing
32. (A) fabricate, (B) fabricated, (C) are fabricated, (D) fabricating, (E) fabrication
33. (A) of, (B) from, (C) to, (D) at, (E) in
34. (A) Of, (B) From, (C) To, (D) At, (E) In
35. (A) did not, (B) does not, (C) doing not, (D) are not, (E) being not

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考試科目 (代碼)：科技英文(1402)

共 8 頁，第 5 頁 \*請在【答案卷、卡】作答

Time: 10:30~12:10 (100 minutes)

Question I, problem 1-30, 2 points for each question.

Question II, problem 31-35, 2 points for each question.

Question III, Problem 36-45, 3 points for each question.

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## Questions III (3 points each)

Below is the information from published Journal papers, please try to answer the following questions.

*Article*

## Metal-Free Fabrication of Fused Silica Extended Nanofluidic Channel to Remove Artifacts in Chemical Analysis

Kyojiro Morikawa <sup>1\*</sup>, Ryoichi Ohta <sup>1</sup>, Kazuma Mawatari <sup>2\*</sup> and Takehiko Kitamori <sup>1,3</sup>

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**Abstract:** In microfluidics, especially in nanofluidics, nanochannels with functionalized surfaces have recently attracted attention for use as a new tool for the investigation of chemical reaction fields. Molecules handled in the reaction field can reach the single-molecule level due to the small size of the nanochannel. In such surroundings, contamination of the channel surface should be removed at the single-molecule level. In this study, it was assumed that metal materials could contaminate the nanochannels during the fabrication processes; therefore, we aimed to develop metal-free fabrication processes. Fused silica channels 1000 nm-deep were conventionally fabricated using a chromium mask. Instead of chromium, electron beam resists more than 1000 nm thick were used and the lithography conditions were optimized. From the results of optimization, channels with 1000 nm scale width and depth were fabricated on fused silica substrates without the use of a chromium mask. In nanofluidic experiments, an oxidation reaction was observed in a device fabricated by conventional fabrication processes using a chromium mask. It was found that Cr<sup>6+</sup> remained on the channel surfaces and reacted with chemicals in the liquid phase in the extended nanochannels; this effect occurred at least to the micromolar level. In contrast, the device fabricated with metal-free processes was free of artifacts induced by the presence of chromium. The developed fabrication processes and results of this study will be a significant contribution to the fundamental technologies employed in the fields of microfluidics and nanofluidics.

**Keywords:** microfluidics; nanofluidics; extended nanochannel; nanofabrication; fused silica; metal-free

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考試科目 (代碼)：科技英文(1402)

共 8 頁，第 6 頁 \*請在【答案卷、卡】作答

Time: 10:30~12:10 (100 minutes)

Question I, problem 1-30, 2 points for each question.

Question II, problem 31-35, 2 points for each question.

Question III, Problem 36-45, 3 points for each question.

No points will be deducted for incorrect answers.

36. How many corresponding author(s) is/are shown in this article?  
(A) 0, (B) 1, (C) 2, (D) 3, (E) 4
37. When the authors submitted the manuscript to the journal?  
(A) 29 June 2021, (B) 30 July 2021, (C) 31 July 2021, (D) Approximately 1 month, (E) not shown
38. What does not allow us to use nanochannels for chemical reaction fields?  
(A) single-molecule, (B) contamination of the channel surface, (C) 1000 nm-deep nanochannel, (D) 1000 nm-thick resist, (E) fused silica substrate
39. What is "metal-free fabrication process" mentioned in this article?  
(A) to fabricate 1000 nm-deep nanochannel, (B) to fabricate nanochannel with chromium mask, (C) to fabricate nanochannel without chromium mask, (D) to observe oxidation reaction, (E) to keep chromium on the channel surface
40. To what extent did remained chromium on the nanochannel surface induce artifact?  
(A) single molecule level, (B) 1000 nm-deep level, (C) 1000 nm-thick level, (D) micromolar level, (E) not observed
41. What was achieved by metal-free fabrication process?  
(A) contamination of the nanochannel surface, (B) fabrication of 1000 nm-deep nanochannel, (C) Optimization for channels with 1000 nm scale width and depth, (D) to induce oxidation reaction, (E) observation without artifact

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考試科目 (代碼)：科技英文(1402)

共 8 頁，第 7 頁 \*請在【答案卷、卡】作答

Time: 10:30~12:10 (100 minutes)

Question I, problem 1-30, 2 points for each question.

Question II, problem 31-35, 2 points for each question.

Question III, Problem 36-45, 3 points for each question.

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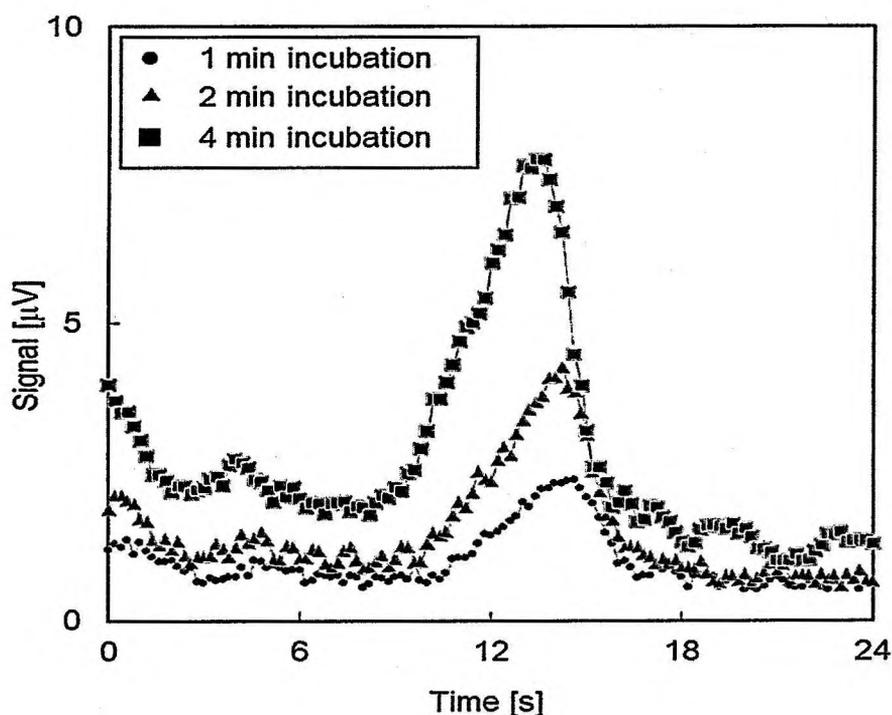


Figure 1: Signals for TMB (3,3',5,5'-tetramethylbenzidine) solutions with various incubation times. Signals were obtained, that indicated the oxidation of TMB, and the progress of the reaction is indicated by the increase in the signal intensity with increasing incubation time.

42. What is the value of maximum signal intensity in the condition of "1 min incubation" ?  
(A) 6 s, (B) 12 s, (C) 1  $\mu$ V, (D) 3  $\mu$ V, (E) 8  $\mu$ V
43. What is mainly discussed by the authors using this Figure?  
(A) background signal, (B) signal starting to increase at 10 s, (C) appeared signal peak around 13 s,  
(D) progress of reaction with increasing incubation time, (E) fast reaction within 20 s

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考試科目 (代碼)：科技英文(1402)

共 8 頁，第 8 頁 \*請在【答案卷、卡】作答

Time: 10:30~12:10 (100 minutes)

Question I, problem 1-30, 2 points for each question.

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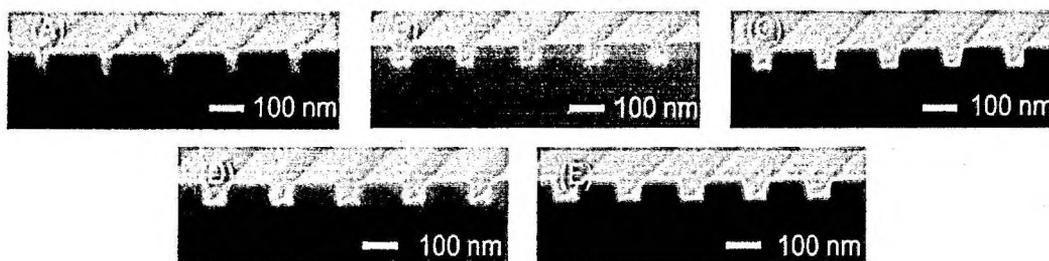


Figure 2: SEM images of nanochannels fabricated using exposure times of (A) 0.4, (B) 0.5, (C) 0.6, (D) 0.7 and (E) 0.8  $\mu\text{s}/\text{dot}$ . In this process, the electron beam resist was spin-coated onto a fused silica substrate at 5000 rpm. Electron beam lithography was subsequently performed while varying the exposure time. After electron beam exposure, the resist was developed with *o*-xylene for a time span of 1.5 min, following which the nanochannels were dry etched with gaseous of  $\text{SF}_6$  and  $\text{CHF}_3$ . The nanochannels in (A) had a triangular shape because the exposure time was not optimized, and some resist was retained in the nanochannel region after development. In contrast, the nanochannels in (B)–(E) exhibit approximately rectangular shapes. With increases in the exposure time, the nanochannels also became wider, and the optimal exposure time was determined to be 0.5  $\mu\text{s}/\text{dot}$ . Using this exposure, nanochannels with dimensions of  $48 \pm 3$  nm (width) and  $49 \pm 1$  nm (depth) with approximately square shapes were obtained.

44. Choose **incorrect** answer about the fabrication process in Figure 2.

- (A) Electron beam resist was spin-coated, (B) Lithography was performed by electron beam, (C) The fused silica was etched by *o*-xylene, (D) Gaseous of  $\text{SF}_6$  and  $\text{CHF}_3$  were used for dry etching, (E) None

45. Choose **correct** answer about discussion in this Figure 2.

- (A) Rectangular nanochannels were fabricated in all condition, (B) Exposure time was not critical parameter, (C) With decreases in the exposure time, nanochannel became narrower, (D) Nanochannels with dimensions less than 50 nm were difficult to fabricate, (E) None