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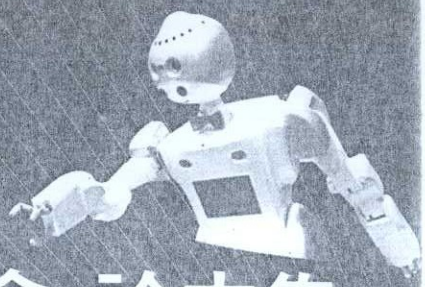

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◎ 후원: 한국과학기술단체총연합회
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C2 MEMS and Actuators / 15:00 - 16:15
Session Chair : 이희철(한국산업기술대학교)

C3 Seecial Symposium Topic : 실내 공기질 관리기술
Session Chair : 오명도(서울시립대학교)

Electrochemical etching system for the fabrication of stepped shape tip

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Abstract

In this paper, we introduce a novel fabrication method of a tungsten tip for STM and FIM applications. It use a self-modified meniscus phenomena caused by help of a Teflon structure with the hydrophobicity. The fabricated tungsten tips have curvature radius less than 50nm. Good reproducibility is also demonstrated using the method. And we also have characterized the field emission behavior of the etched W-tips.

Key Words : tungsten tip, self-modified, meniscus, reproducibility

1. Introduction

Scanning tunneling microscopy (STM) is based on the phenomenon that electrons can tunnel across the potential barrier. The unique sensitivity of STM stems from exponential dependence of the measured tunneling current on tip-sample separation. The goal is to produce a sharp metal tip with a low-aspect ratio to minimize flexural vibrations. The mechanism and methods of tungsten tip etching have been extensively studied. Among the common methods used for producing high-quality tips with atomic resolution, electrochemical etching is a fast and the most convenient method used foe obtaining cheap and reliable tips[1].

In this article, we proposed a novel electrochemical etching system with the aim of fabricating the high reproducibility. Our, especially, method has no need to control the cut-off time for w-tip sharpness.

2. Fabrication and field emission measurement

Our tip fabrication system is based on the basic drop-off etching procedures, while modifying some aspects to improve the tip sharpness and to easy control. Fig. 1 shows schematically the arrangement used for W-tip fabrication system. The tungsten wire in etch configuration was immersed to a depth of 8mm in 2M KOH). The KOH depth was adjusted to be level with the Teflon structure (30mm× 30mm× 10mm). Both cathode and anode are used same tungsten and held through micro-manipulators. The experimental set up consisted of a DC(5V) power supply and a Labview system to obtain current change according to etching time. When the etching solution fill in the Teflon structure, the angle and force of the meniscus at tungsten wire surface are increased by the hydrophobicity of Teflon. This meniscus height is about 1 mm and it is to be etched W-tip length.

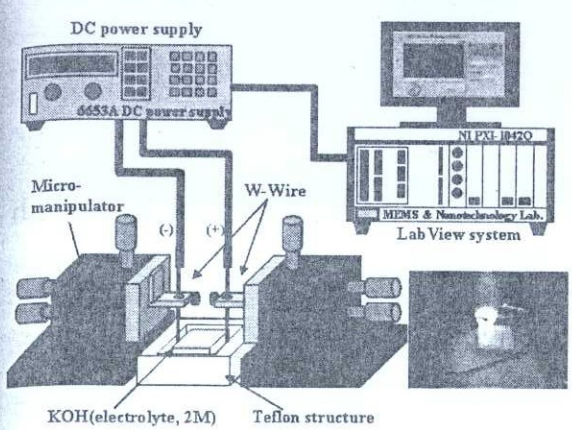

Fig. 1. Schematic diagram of electrochemical etching system.

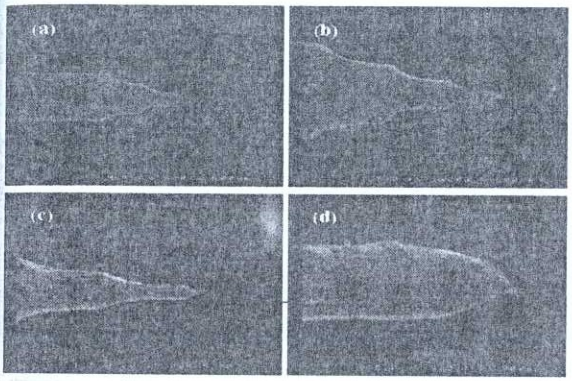

Fig. 2. SEM images of a etched W-tip, (a-b), cleaned W-tip after field emission (c-d).

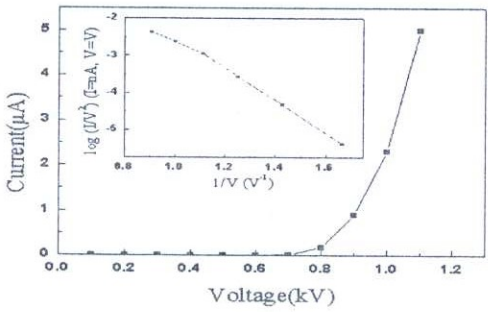

Fig. 3. Emission current vs. voltage characteristics of etched w-tip. (Inset: Fowler-Nordheim plot.)

During electrochemical etching process, the change in current according to bias voltage is generated. We know that the rapidly decreased current signal is reforming meniscus as to self-modified phenomenon. Fig. 2 is SEM images of etched tungsten tip using our proposed etching system and cleaned w-tip after field emission process.

The fabricated tungsten tips have a curvature radius less than 50nm. For the field emission experiments, the w-tip is connected to the phosphor screen through a sourcemeter (Keithely, 2410). A positive dc voltage on the phosphor screen is slowly increased to measure emission behaviors. The measured emission current that flows from the w-tip to the phosphor screen in vacuum (1.5 X 10^{-5} Pa) is plotted as a function of applied voltage. Fig. 3 shows the field mission characteristics of our w-tip. The inset shows a Fowler - Nordheim plot of the I-V curves. The turn-on voltage of the w-tip for field emission is about 0.6 V_{DC}.

3. Results

In summary, we have found a simple and reliable method to prepare w-tips for the STM. The curvature radius of the tips has a curvature radius less than 50nm and good reproducibility. And we also have characterized the field emission behavior of the etched W-tips. The electron beams field emitted from these tips possesses high stability.

Acknowledgements

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References

[1] O. L. Guise, J. W. Ahner, M. C Jung, P. C. Goughnour, and J. T. Yates, Jr., "Reproducible electrochemical etching of tungsten probe tips", *Nano Lett.*, vol. 2, no. 3, 2002.