Photos courtesy of Masumi Hirabayashi, Associate professor, National Institute for Physiological Sciences

Specimen1: Injection of rat's ES cell into 8-cell embryo

Specimen2: Microinsemination of rat egg

Micromanipulators and related equipment other than microscopes are manufactured by:

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Printed in Japan (0912-07)T

Code No. 2CE-MRRH-2

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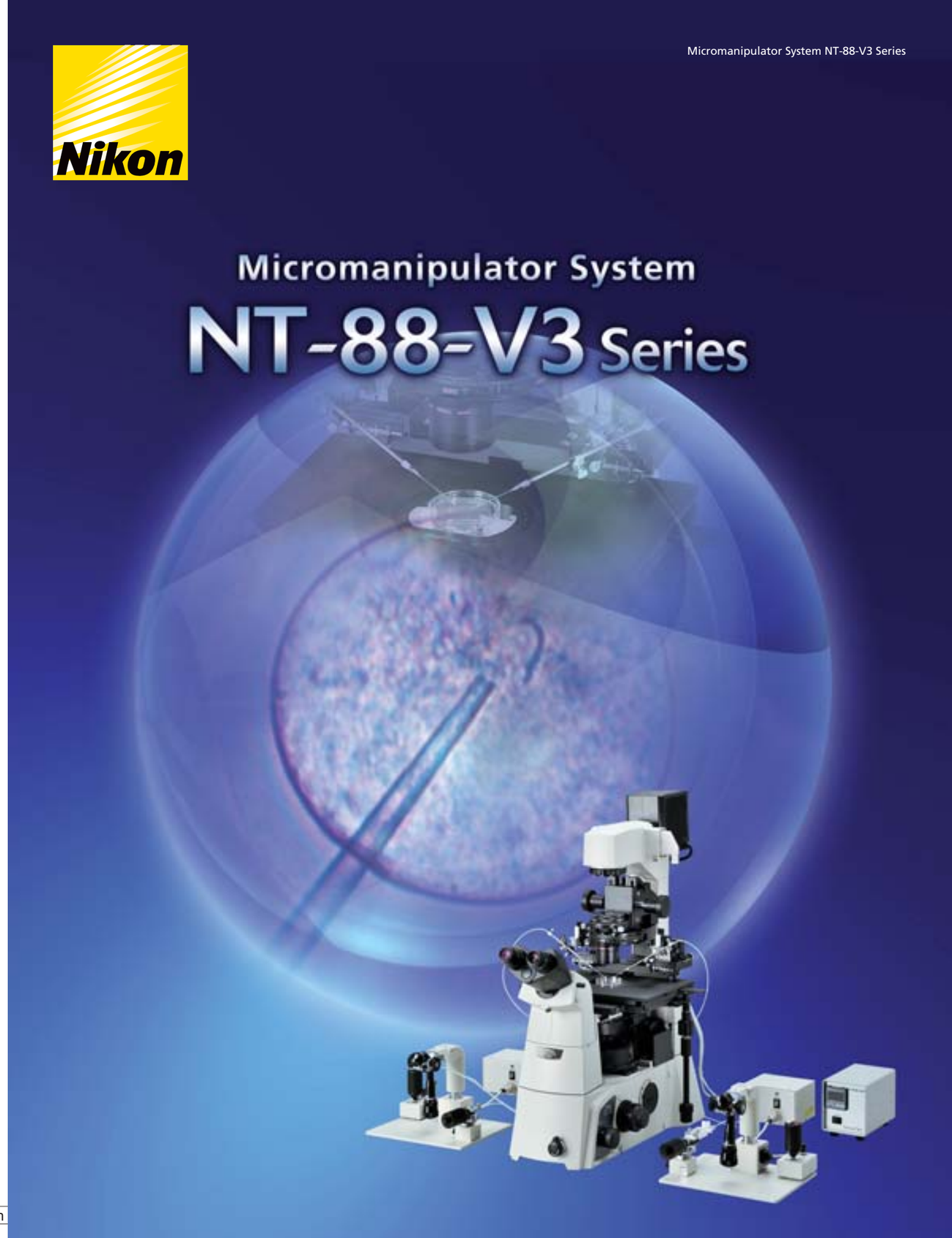
Micromanipulator System NT-88-V3 Series



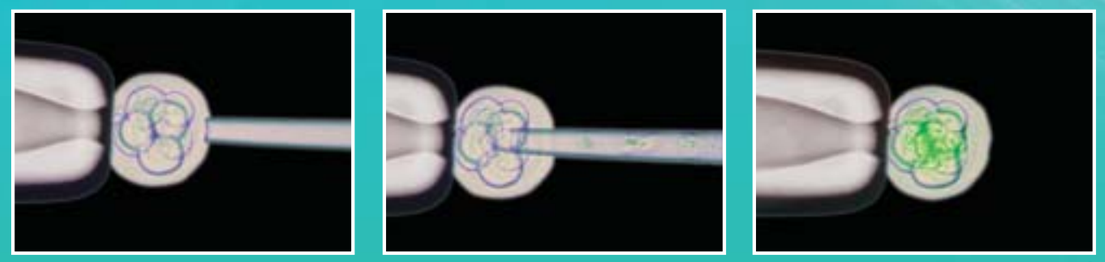
Fusion of Utmost Precision and Fine Mechanism

ICSI (Intracytoplasmic sperm injection) and IMSI (Intracytoplasmic morphologically selected sperm injection), IVF (In vitro fertilization) technologies that have received a lot of attention in recent years as a remedy for male infertility, require a highly precise manipulator to respond to delicate movement of the operator's hands.

Stable, smooth manipulation is also required for injection to the stem cell, transgenics and electrophysiology.

The NT-88-V3 series, jointly developed by Nikon and Narishige, ensures easy operation and an unsurpassed level of precision. When used in combination with Nikon's high-performance microscopes, it provides strong support for cutting-edge biomedical research.

- **Size is greatly reduced as the 3D motor-driven coarse control manipulator and 3D hydraulic fine micromanipulator are combined in a single unit.**
- **Assembly of the micromanipulator is fast and easy due to the extremely stable, one-piece mounting adapter.**
- **Wide varieties of microinjectors for holding or injecting specimens depending on use.**



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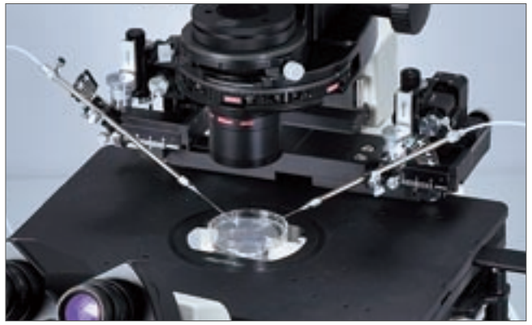
Oil-hydraulic Micromanipulators

3D Hydraulic Micromanipulator
NT-88-V3

Combined 3D motor-driven coarse control manipulator and the 3D hydraulic fine micromanipulator realize remarkably compact and stable design.

- Less than half the size of a conventional model—minimal length tubes and cords—the manipulator fits easily into the incubator.
- Closer-to-the-center settings are possible, while reduced distance from manipulator mount to microelectrode tip increases stability.
- X-axis control knobs are located symmetrically on opposite sides of the joystick to eliminate left side/right side positioning problems.
- 10mm X-Y operating range provides versatility in manipulation at lower magnifications.
- A "resume" feature returns the pipette to the original position after the pipette has been raised for quicker, easier Petri dish changes.
- The universal joint is outfitted with an angle gauge, which ensures accurate-angle operation. The forward-mounted return mechanism facilitates Petri dish changing.
- Permits one-touch installation on an inverted microscope.



Hanging joystick design for optimal ergonomics and user comfort during long periods of use

3D Hydraulic Micromanipulator (Single-hand type)
NT-88-V3SH

Suitable for experiments that do not require the holding side's pipette, such as the microinjection or microdissection to an adherent cell

3D Hydraulic Micromanipulator (Manual Single-hand type)
NT-88-V3MSH

A manual 3D coarse positioning manipulator allows you to quickly move the micro-pipette to the ideal position. And the compact design allows you to position it closer to you with the control knob in easy reach.

		NT-88-V3	NT-88-V3SH	NT-88-V3MSH
Hydraulic fine micromanipulator				
Working range	Control knob operation	Max. 10mm		
	Joystick operation	Max. 2mm		
Displacement by control knob rotation	Full turn of knob	250µm		
	Minimum graduation	2µm		
Coarse manipulator				
Working range		Max. 22mm (motorized)		Max. 30mm (manual)

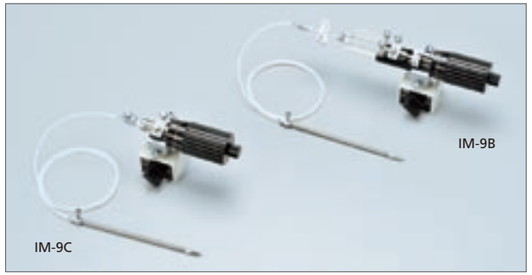
Universal Joint
UJ-V3

Universal Joint UJ-V3 allows the pipette holder to be moved in a single direction. The angle can be adjusted for both vertical and horizontal directions via two separate control knobs. The forward-mounted return mechanism facilitates changing the petri dish while the built-in angle gauge ensures accurate-angle operation. Moreover, because the UJ-V3 is mountable from above, unlike the conventional type, attachment and removal is much easier.

Oil-type Microinjector IM-9B
Pneumatic Injector IM-9C

The IM-9B, which is suitable for injection, and the IM-9C, which is suitable for holding, provide smoother and more stable maneuverability by applying a new mechanism to minimize backlashes. Also, their 53mm working distance, large-volume syringe and just-the-right-size control knob with graduated scales all contribute to easy control of the injection. The IM-9B has a glass syringe for easy confirmation of internal air bubbles while its new tube connector with a three-way stopcock makes for easier filling of oil without generating air bubbles.

	IM-9B	IM-9C
Movement distance		
Movement range	53mm	53mm
Full rotation of knob	500µm	6mm
Control value		
Full rotation of knob	Approx. 10µl	Approx. 480µl
Syringe	1,060µl glass type	4,240µl metal type



Pipette Holder HI-7 with Rotating Mechanism HIR

The HI-7 pipette holder provides improved protection against oil leaks. Alignment of the pipette tip in the microscope field is now a simple procedure with the rotating mechanism HIR.

Microscope Adapters for NT-88-V3

Various adapters are available for use with Nikon microscopes. As both adapters and manipulators are compact, attaching them is very easy.

NS-TEV3
Mounting Adapter to use with inverted microscopes Ti and TE2000

NS-T1
Mounting Adapter to use with inverted microscope TS100

NS-SMV3
Mounting Adapter to use with stereoscopic microscope SMZ series
It can be adapted to the diascopic stand of the SMZ series.

NS-FNV3
Mounting Adapter to use with fixed stage microscope FN1
Two adapters are necessary when mounting a micromanipulator on both sides.

Micromanipulators for electro-physiology applications

3D Water-Hydraulic Micromanipulator

MHW-3

The MHW-3 features minimized drift due to temperature changes, a scale increment as small as 0.2µm, and a fine control manipulation with a one-to-five moving ratio. Also, because Teflon tubes are secured to the microscope main body, vibration of the tip of the micropipettes has been eliminated, resulting in stable micromanipulation.

MHW-3 with NN-L3 adapter, configured with patch amplifier

Movement range	Fine 2mm (X, Y and Z axes), coarse 30mm (X, Y and Z axes)
Full rotation of knob	50µm
Minimum graduation	Fine 0.2µm

3D Motorized Micromanipulator

MM-80

The MM-80 has been developed to satisfy the competing goals of "stability" and "compactness" that are essential for research work in electrophysiology.
The motorized micromanipulator is constructed in a simplified design with its controller employing simple-design push button switches. The drive unit embodies user-friendly convenient features which help reduce stress during experiments.

Movement range		Fine 20mm (X, Y and Z axes), coarse 30mm (X, Y and Z axes)
Driving speed (Motorized fine drive)	Minimum	Approx. 10µm/s*
	Maximum	Approx. 150µm/s*

* DC motor drive, theoretical value

Manual 3D Micromanipulators

NMN-21/25

The NMN-21 and -25 are designed for drift-free operation, making them ideal for delicate, patch-clamp research. The unit has no hydraulic system nor spring mechanism and its unique double-slider structure minimizes vibrations transmitted from the operator's hand to the tip of the pipette via the control knob. The unit's motor-less and actuator-less design also eliminates electromagnetic disturbances. The NMN-25 features a compact, space-saving design without a scale.

NMN-21

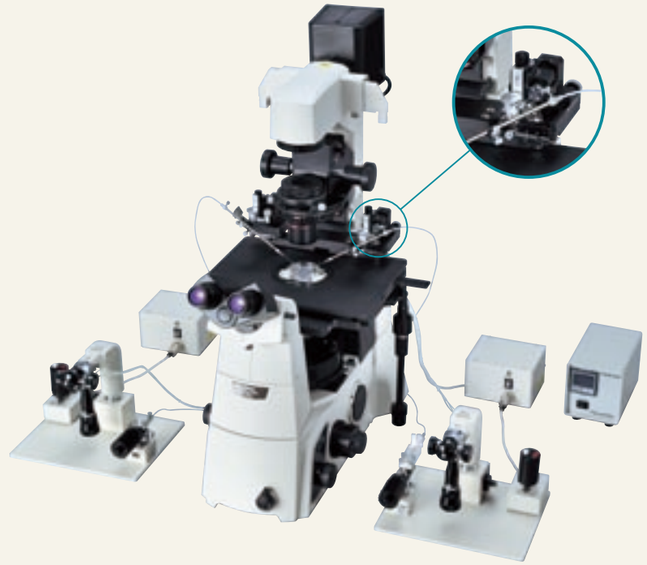
	NMN-21	NMN-25
Movement range	Fine 6mm (X, Y and Z axes), coarse 15mm (X, Y and Z axes)	Fine 6mm (X and Z axes), coarse 15mm (X and Z axes), combined coarse and fine working range 15mm (Y axis)
Full rotation of knob	Fine 250µm, coarse approx. 4mm	Fine 250µm (X and Z axes), approx. 250µm (Y axis)
Minimum graduation	Fine 1µm	—

Recommended combination for various applications

For ICSI (Intracytoplasmic Sperm Injection), ES cell injection and nucleus transfer

The microinjection system is dedicated to floating cell applications. The inner diameter of the pipette tip is more than 5µm. For the injection of the sperm, embryo-stem cell and nucleus, a manual injector is suitable as it accurately transmits the movement of user's hand via the handle.

Product	Unit	Model name
Components		
Microscope	1	Ti-U NAMC set
3D hydraulic micromanipulator	1	NT-88-V3
Microinjector (injection side)	1	IM-9B
Pneumatic injector (holding side)	1	IM-9C
Stage thermal control system: Thermo Plate	1	MATS-U505R30
Options for making pipettes		
Puller	1	PC-10
Microgrinder	1	EG-400
Microforge	1	MF-900
Glass capillaries	1	G-1



For injection into adherent cells

The microinjection system for adherent cells incorporates a one-axis oil hydraulic micromanipulator—it moves in the direction of a pipette—only on the injection side, since it does not require an injector on the holding side. A motorized injector that can accurately control the injection amount of DNA and fluorescence dyes is suitable.

Product	Unit	Model name
Components		
Microscope	1	Ti-U DIC set
3D hydraulic micromanipulator (single-hand type)	1	NT-88-V3SH
Mounting adapter	1	NS-TEV3
1D hydraulic micromanipulator	1	MMO-220A
Motorized microinjector	1	IM-300
Stage thermal control system: Thermo Plate	1	MATS-U505R30
Options for making pipettes		
Puller	1	PC-10
Glass capillaries	1	GD-1

Single-cell patch clamping with inverted microscope

This system is suitable for single-cell patch clamp experiments using an inverted microscope. Two units, one each for recording and stimulating, are included. A water-hydraulic micromanipulator effective for general manipulations is suitable.

Product	Unit	Model name
Components		
Microscope	1	Ti-U DIC set
Mounting adapter	1	NN-L3
3D water-hydraulic micromanipulator	2	MHW-3
Patch amplifier adapter*	1	AP-12A/L/N or AP-13-2
Options for making pipettes		
Puller	1	PC-10
Microforge	1	MF-830
Glass capillaries	1	GD-1.2
Glass capillaries	1	GD-1.5

* Please select an adapter that suits the brand of patch amplifier used.

Single-cell patch clamping with upright microscope

This system is suitable for single-cell patch clamp experiments using an upright microscope. Two units, one each for recording and stimulating, are included. A water-hydraulic micromanipulator effective for general manipulations is suitable.

Product	Unit	Model name
Components		
Microscope	1	FN1-DIC set
Mounting adapter	1	NN-R
3D water-hydraulic micromanipulator	2	MHW-3
Patch amplifier adapter*	1	AP-12A/L/N or AP-13-2
Options for making pipettes		
Puller	1	PC-10
Microforge	1	MF-830
Glass capillaries	1	GD-1.2
Glass capillaries	1	GD-1.5

* Please select an adapter that suits the brand of patch amplifier used.

Manual patch clamping

This system is suitable for patch clamp experiments on slice cells using an upright microscope. The two stages that incorporate new functions were developed especially for the FN1. One is independent from the microscope and the other, a manual XY stage, enables the microscope's observation field to be changed. Though three water-hydraulic micromanipulators are used in the picture, any number can be selected.

Product	Unit	Model name
Components		
Microscope	1	FN1-DIC set
Stage	1	ITS-FN1
3D water-hydraulic micromanipulator	3	MHW-3
Patch amplifier adapter*	2**	AP-12A/L/N, AP-13-2
Options for making pipettes		
Puller	1	PC-10
Microforge	1	MF-830
Glass capillaries	1	GD-1.2
Glass capillaries	1	GD-1.5

* Please select an adapter that suits the brand of patch amplifier used.
** Any one of the following combinations is possible: AP-12A/L/N x2, AP-13-2 x1, AP-12A/L/N x1 + AP-13-2 x2

Blind patch clamping with stereoscopic microscope

This system uses a stereoscopic microscope for patch clamp experiments. A cost efficient water-hydraulic micromanipulator is suitable for this application.

Product	Unit	Model name
Components		
Microscope	1	SMZ1500 diascopic, LWD set
Mounting adapter	1	NN-T-2
Water-hydraulic micromanipulator	1	MWS-1B
Patch amplifier adapter*	1	AP-14A/L/N or AP-13-3
Options for making pipettes		
Puller	1	PC-10
Glass capillaries	1	GD-1.2
Glass capillaries	1	GD-1.5

* Please select an adapter that suits the brand of patch amplifier used.

Accessories

Micropipette Puller PC-10
The PC-10 is used to pull the glass capillary vertically, utilizing the gravitational force of its own weight. It has two modes: a single pull, pulling capillary at one stretch, and a double pull in which the setting is changed in mid-process. The versatile vertical pull type is suitable for both injection purposes and patch clamping.

Pipette Grinder EG-400
The grinder with minimized irregular movements of the grinding plane and the microscope are combined. Precise grinding while confirming needle contact with grinding plane is facilitated.

Microforge MF-900
The MF-900 is designed to produce injection and holding pipettes. In addition to the temperature and illumination, the position of the heating element can be adjusted.

Microforge MF-830
A powerful microscope with 525x total magnification is incorporated to make electrodes with tips less than 2µm for patch clamping.

Glass Capillaries G-1
The general purpose glass capillary G-1 has been prewashed in an ultrasonic washing machine.

Glass Capillaries with Filament GD-1, GD-1.2, GD-1.5
Commonly known as double tubing, these glass capillaries contain an internal glass fiber (approx. 100µm). GD-1 has been prewashed in an ultrasonic washing machine.

Automatic Microscope Stage Thermal Control System Thermo Plate MATS-U505R30
The flat surface of the plate enables easy manipulator operation and specimen changes.
(Manufactured by Tokai Hit Co., Ltd.)

Automatic Microscope Stage Thermal Control System Thermo Plate MATS-USMZSL
It can be easily attached to the microscope by inserting it into the stage plate hole. As its shape fits the stage, the thermal control of the wide area of the specimen is possible. The flat surface of the plate enables easy manipulator operation and specimen changes.
(Manufactured by Tokai Hit Co., Ltd.)

Compatibility of patch amplifier adapters

Headstage maker and model name		Manipulator/Patch amplifier adapter				
		MHW-3	MM-80	NMN-21 NMN-25	MWS-1B	MHW-4
AXON	HS-2	AP-12A	AP-14A			
	HS-4					
	VG-2					
	VG-2A					
	CV-4					
	CV-5					
	CV-202 (CV-201AU)					
	CV-203BU	AP-13-2	AP-13-3			
	CV-7A/B					
	HS-9A					
HEKA	EPC-7	AP-12L	AP-14L			
	EPC-8					
	EPC-9					
	EPC-10	AP-13-2	AP-13-3			
Nihon Kohden	JZ-230J	AP-12N	AP-14N			
	JZ-240J					
	JZ-245J					

Patch amplifier adapter