World Precision Instruments, Inc.

USA
International Trade Center, 175 Sarasota Center Blvd., Sarasota FL 34240-9258
Tel: 941-371-1003 • Fax: 941-377-5428 • E-mail: sales@wpiinc.com

UK
Astonbury Farm Business Centre • Aston, Stevenage, Hertfordshire SG2 7EG
Tel: 01438-880025 • Fax: 01438-880026 • E-mail: wpiuk@wpi-europe.com

Germany
Liegnitzer Str. 15, D-10999 Berlin
Tel: 030-6188845 • Fax: 030-6188670 • E-mail: wpide@wpi-europe.com

Internet
www.wpiinc.com • www.wpi-medical.com
www.nitricoxide.net • www.pipetter.com

CF10, CF30, CD30

Carbon fiber and carbon disc microelectrodes for use with MicroC™ potentiostat

INSTRUCTION MANUAL

Serial No._____

031502

World Precision Instruments

Warranty

WPI (World Precision Instruments, Inc.) warrants to the original purchaser that this equipment, including its components and parts, shall be free from defects in material and workmanship for a period of one year* from the date of receipt. WPI's obligation under this warranty shall be limited to repair or replacement, at WPI's option, of the equipment or defective components or parts upon receipt thereof f.o.b. WPI, Sarasota, Florida U.S.A. Return of a repaired instrument shall be f.o.b. Sarasota.

The above warranty is contingent upon normal usage and does not cover products which have been modified without WPI's approval or which have been subjected to unusual physical or electrical stress or on which the original identification marks have been removed or altered. The above warranty will not apply if adjustment, repair or parts replacement is required because of accident, neglect, misuse, failure of electric power, air conditioning, humidity control, or causes other than normal and ordinary usage.

To the extent that any of its equipment is furnished by a manufacturer other than WPI, the foregoing warranty shall be applicable only to the extent of the warranty furnished by such other manufacturer. This warranty will not apply to appearance terms, such as knobs, handles, dials or the like.

WPI makes no warranty of any kind, express or implied or statutory, including without limitation any warranties of merchantability and/or fitness for a particular purpose. WPI shall not be liable for any damages, whether direct, indirect, special or consequential arising from a failure of this product to operate in the manner desired by the user. WPI shall not be liable for any damage to data or property that may be caused directly or indirectly by use of this product.

Claims and Returns

• Inspect all shipments upon receipt. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed loss or damage should be reported at once to the carrier and an inspection requested. All claims for shortage or damage must be made within 10 days after receipt of shipment. Claims for lost shipments must be made within 30 days of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim settles. In some instances, photographic documentation may be required. Some items are time sensitive; WPI assumes no extended warranty or any liability for use beyond the date specified on the container.

• WPI cannot be held responsible for items damaged in shipment en route to us. Please enclose merchandise in its original shipping container to avoid damage from handling. We recommend that you insure merchandise when shipping. The customer is responsible for paying shipping expenses including adequate insurance on all items returned.

• Do not return any goods to WPI without obtaining prior approval and instructions (RMA#) from our returns department. Goods returned unauthorized or by collect freight may be refused. The RMA# must be clearly displayed on the outside of the box, or the package will not be accepted. Please contact the RMA department for a request form.

• Goods returned for repair must be reasonably clean and free of hazardous materials.

• A handling fee is charged for goods returned for exchange or credit. This fee may add up to 25% of the sale price depending on the condition of the item. Goods ordered in error are also subject to the handling fee.

• Equipment which was built as a special order cannot be returned.

• Always refer to the RMA# when contacting WPI to obtain a status of your returned item.

• For any other issues regarding a claim or return, please contact the RMA department.

Warning: This equipment is not designed or intended for use on humans.

** Electrodes, batteries and other consumable parts are warranted for 30 days only from the date on which the customer receives these items.*

solution. Experimental evidence further indicates that both the absorption and capacitance of carbon fiber electrodes reach plateaus when they are activated in solutions with pH ranging from 10 to 13. Taking these two factors into consideration, it is recommended that a medium base solution (*i.e.*, pH 9.5 salt solution) be used for electrochemical activation of fiber electrodes. Illustrated in Figures 2 and 3 are the responses of WPI's carbon fiber electrode CF8-1 (8 µm diameter, 1 mm in length) to applications of 10 µM of dopamine before (Figure 2) and after (Figure 3) the electrochemical activation of the electrode. The activation procedure not only improved the response reversibility of the electrode but also increased its sensitivity by nearly 10 times.

It is therefore suggested that all of WPI's carbon fiber electrodes be activated in pH 9.5 salt solution (*i.e.*, NaCl 150 mM), at 1.2 V (relative to an Ag/AgCl electrode) for 5-10 minutes before use/reuse/calibration.

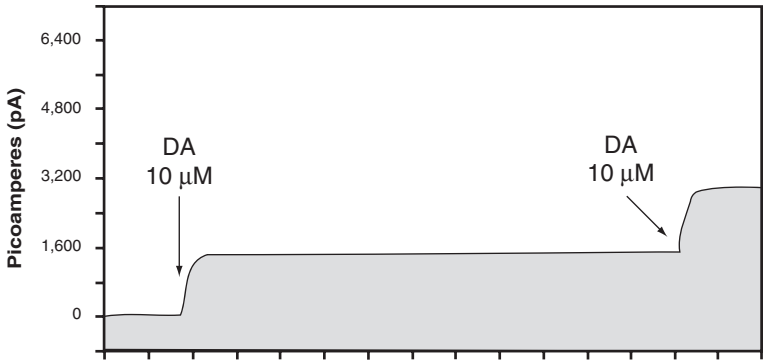

Fig. 3 — Current response after activation

WPI's ultra-sensitive carbon microelectrodes can be used, with WPI's low-noise carbon fiber potentiostat/picoammeter, MicroC, for the electrochemical detection of oxidizable biological compounds such as epinephrine (EP), norepinephrine (NE), serotonin (5-HT) and dopamine (DA). Carbon fiber electrodes (**CF30-1**, **CF30-05**, **CF8-1**, **CF8-05**) are constructed from either 30 or 8 micrometer fibers.

Carbon disc electrodes (**CD-30**) are made by filling a very conductive carbon mixture into pulled glass pipettes. These carbon disk electrodes are especially useful in electrochemical study of the kinetics of biological compounds since they can be apposed closely to single cells.

Carbon Fiber Electrode Specifications

Type	Diameter	Length	Impedance*	I	Detect. Limit
	(µm)	(mm)	(MΩ)	(back, pA)	(nM)
CF30-1	30	1	0.08-0.35	50-150	0.2-5
CF30-05	30	0.5	0.20-0.65	40-120	0.2-10
CF8-1	8	1	0.25-0.75	30-100	1-50
CF8-05	8	0.5	0.35-1.00	20-70	1-50
CD-30	30	0	0.30-2.50	10-120	100-250

Notes:

1. Impedance serves as a useful index to assess active carbon area. Lower impedance and larger background current yields a lower detection limit. A small increase in impedance reading may be observed from time to time, which is thought due to the formation of the electrochemical graphite oxide film on the carbon fiber.

2. The detection limit is defined as the concentration of compound needed to evoke 1 pA of redox current response. It was determined using dopamine as the oxidizable agent and uncoated electrodes (see the following section on selectivity).

3. Electrode impedance was measured on WPI's OmegaTip-Z meter. The background currents were measured using WPI's MicroC with an electrode poise voltage of +0.65 V in pH 7.4 salt solution. The listed values are taken at least five minutes after the electrodes are soaked in saline.

** Electrode impedance is measured using WPI's OmegaTip-Z*

Selectivity

In the electrochemical study of cationic primary neurotransmitters such as DA, NE, and 5-HT, discrimination against the interference of such chemicals as ascorbic acid is very important in brain tissue research. The selectivity is achieved usually by coating carbon electrodes with Nafion, a perfluorosulfonated polymer. The polymer membrane formed on the electrode surface responds minimally to ascorbic acid, strongly rejecting passage of anionic metabolites, and is highly selective for cationic species such as DA, NE and 5-HT, all of which are protonated at physiological pH. A ratio of 200:1 in sensitivity to the cationic compounds vs. ascorbic acid can be easily achieved by electro-coating a carbon electrode in a 1-5% Nafion solution. Shown in Figure 1 is the time course of the current response, measured using WPI's MicroC potentiostat and a Nafion-coated fiber electrode (CF30-05) to a solution containing 10 µM ascorbic acid and 10 µM dopamine.

WPI can supply Nafion-coated carbon fiber electrodes. Experimental data indicates that WPI's Nafion-coated carbon electrodes not only show excellent selectivity for cationic compounds but also have increased sensitivity to them (up to 50% greater) in comparison with the uncoated electrodes. This is in accordance with an observed decrease in electrode impedance following coating with a Nafion surface membrane.

Users of WPI's uncoated fiber electrodes may choose to coat electrodes before an experiment. To deposit a Nafion membrane, the electrode is dipped into Nafion solution three times, each time for 3-5 seconds, with poise voltage applied. Then air-dry the electrode for 10-15 minutes before experiment.

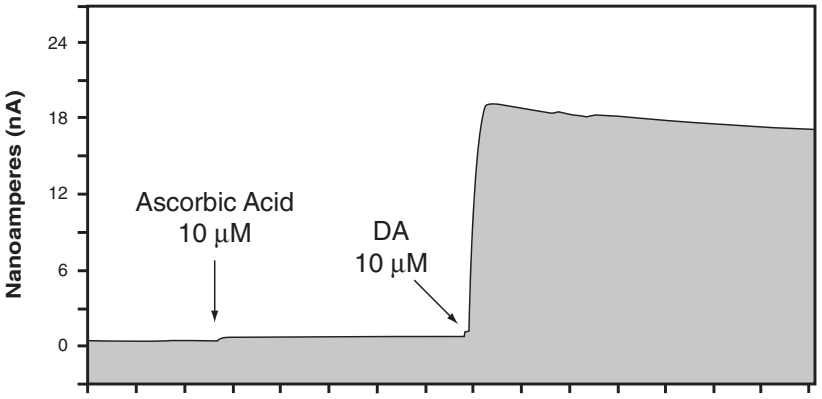

Fig. 1 — Selectivity of the electrode

Sensitivity

WPI's carbon fiber electrodes series CFx-y are of high sensitivity. Using uncoated fiber electrodes, oxidizable compounds such as dopamine with concentration as low as 2 nM can be detected. Detection of 0.20 nM of dopamine was achieved using a Nafion-coated fiber electrode (CF30-1).

Due to their limited tip area, the carbon disc electrodes are about 100-200 times less sensitive than the carbon fiber electrodes. This is consistent with the difference in the exposed carbon surface areas between the fiber and disc electrodes.

Activation of Carbon Fiber Electrodes

Since the first reported use of graphite paste electrodes for detection of electroactive substances in brain tissue, an activation step has been shown to be imperative to obtain a reproducible response from carbon electrodes. Numerous techniques have been proposed for electrochemical activation. One of the most useful activation procedures is electrochemical treatment in a base solution.

Optimum activation conditions were a pH of 13 while applying a potential of +1.2 V for a duration of 5 minutes (Anjo, D.M. *et al., Anal. Chem.*, 61, 2603-2608, 1989). Anjo et al. demonstrated that their procedure minimized electrode absorption and capacitance, and more importantly enhanced the reversibility of response to oxidizable compounds such as catecholamines.

Carbon electrodes are commonly sealed with either epoxy cement or heat-shrink Teflon tubing or polypropylene insulation, which cannot withstand the strong base

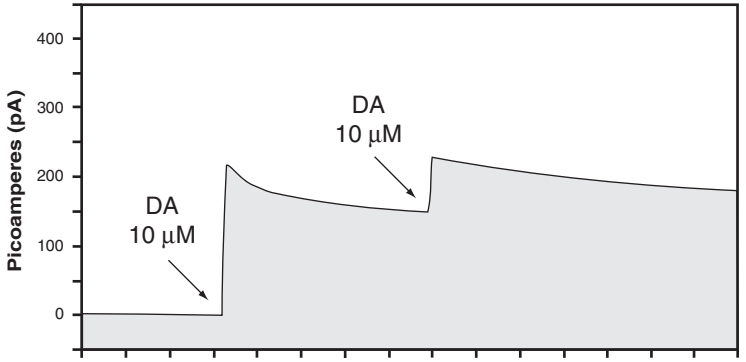

Fig. 2 — Current response before activation