DATA ACQUISITION SYSTEM FOR NANO/MICRO-PORE ANALYSIS IN POLYMERIC SSNTDs

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This paper discusses developing of an innovative PC-based technique for measuring time varying pore-size and pore resistance of nano/micro-pores in polymeric SSNTDs. The paper also discusses the merits of this technique in comparison to the conventional techniques.

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1. Introduction

Nanotechnology is an emerging field blessed with a vast potential for bringing in revolution to the development and advancement of the techniques involved in the fabrication of sensors and devices. Nano/microfabrication refers to the tools and techniques that can be put to use for changing the structure and the properties of matter at the nano or micro scale. Materials with nanoscopic dimensions not only have potential technological applications in various areas but also are of fundamental interest in that the properties of a material can change in this regime of transition between the bulk and molecular scales. Microtechnology relies essentially on the generation of replicas (metallic or nonmetallic) using various types of specially designed cells(1-5). In the recent years there appears to have been a keen interest exhibited towards their fabrication involving materials like metals, nonmetals like semiconductors, polymers, glasses, carbon etc. for the obvious and pertinent reasons that they have many potential and interesting applications in the field of microelectronics, optical and mechanical devices electrochemistry, chemical separation of gases, ID quantum dots/wires or whiskers fabrication, high power microwave generation, ultrafast computer technology, radiation and temperature insensitive electronics, mimics for biological systems, biosensors, drug delivery systems involving micro-encapsulation, conducting polymers, magnetic vertical recording media fabrication, storage of hydrogen and other gases, as a catalyst support and a tip for scanning probe microscopy. The technique used for the generation of replicas is known as Template Synthesis(6-9). Due to the various applications of Track Filters in every field of science and technology, their studies are very useful. These Filters are generally made from polymeric materials and ceramics. In order to produce Track Filters the insulating materials are irradiated by high energy charged particles. Then the chemical etching of these irradiated foils leads to the formation of fine hollow pores. Pore diameter is controlled by the etching parameters such as etching time, etching temperature and etchant concentration etc. In our case etching is done using specially- designed etching cell.

2. Technique of controlled etching

If V_f and V_s be the time varying voltages across the electrodes and the standard resistance R_s respectively, then the total filter resistance, is given by
$R_f = \sigma L/N\pi r^2$; where resistance offered by each pore = $\sigma L/\pi r^2$, and

$$R_f = (V_f/V_s).R_s \quad (1)$$

Thus

$$r = (\sigma L V_s /N\pi V_f R_s)^{1/2} \quad (2)$$

Where R_f = total filter resistance

N = total number of pores in the NTF (in parallel) = $\pi R^2\phi$

R = radius of the foil NTF

r = pore radius

ϕ = number of pores per unit area

L = thickness of the foil, i.e. length of each pore

σ = resistivity of the etchant

V_f = Voltage across the two auxiliary electrodes

V_s = Voltage across the serial resistor R_s

In order to find R_f at any time during etching we measure voltage V_s across R_s (standard resistance of 50 ohm) and V_f across two electrodes across NTF. As the etching process with time dissolves more and more material from the damaged sites the pore size(r) increases whereas the total filter resistance R_f decreases.

The study of R_f vs t and r vs t necessitates the recording of V_s and V_f at the intervals of 10–20 seconds to 1-2 minutes for a period of 1-2 hours. This is obviously a cumbersome, arduous and time consuming process. For sure, manual recording of these observations and subsequent calculations would result in drastic errors. The time-varying V_f and V_s will be monitored by interfacing to a computer(Fig-1). R_f and r are computed using equations (1) and (2) and a specially-designed software making use of already stored known data. The Fig. 3 & 4 show the variation of pore resistance vs time and pore radius vs time respectively.

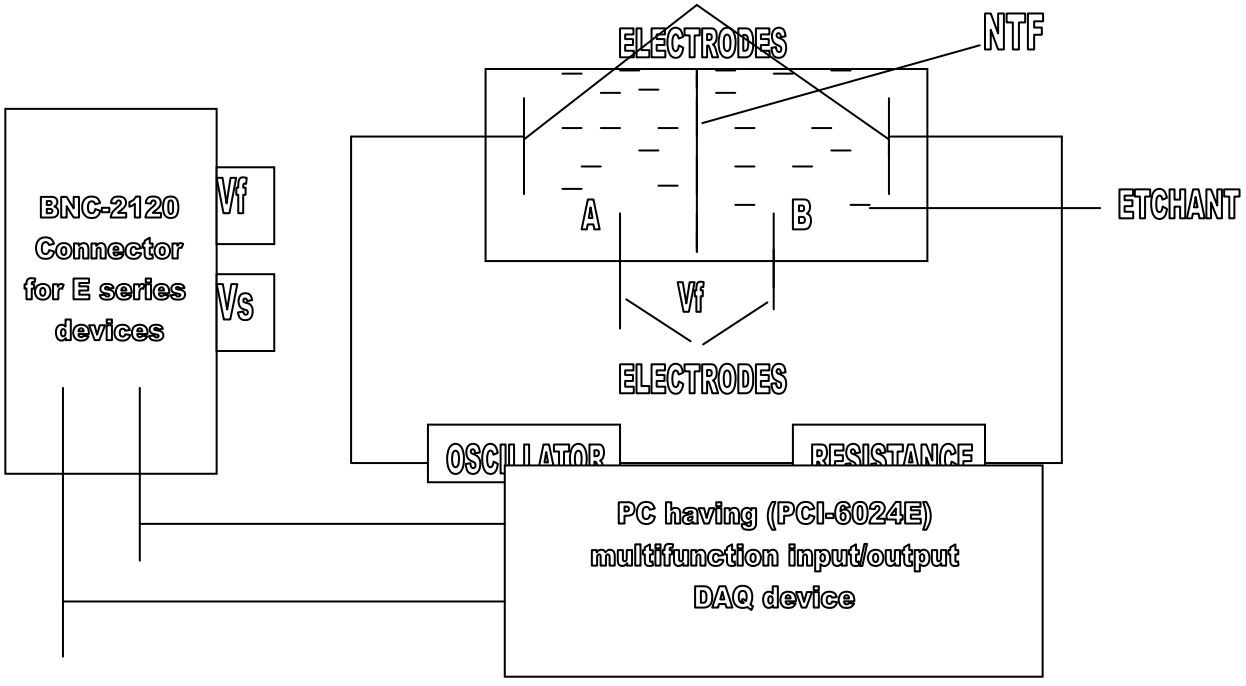

Fig. 1: Block diagram of experimental setup

3. Interfacing technique

The algorithm chart for the interfacing is shown as below

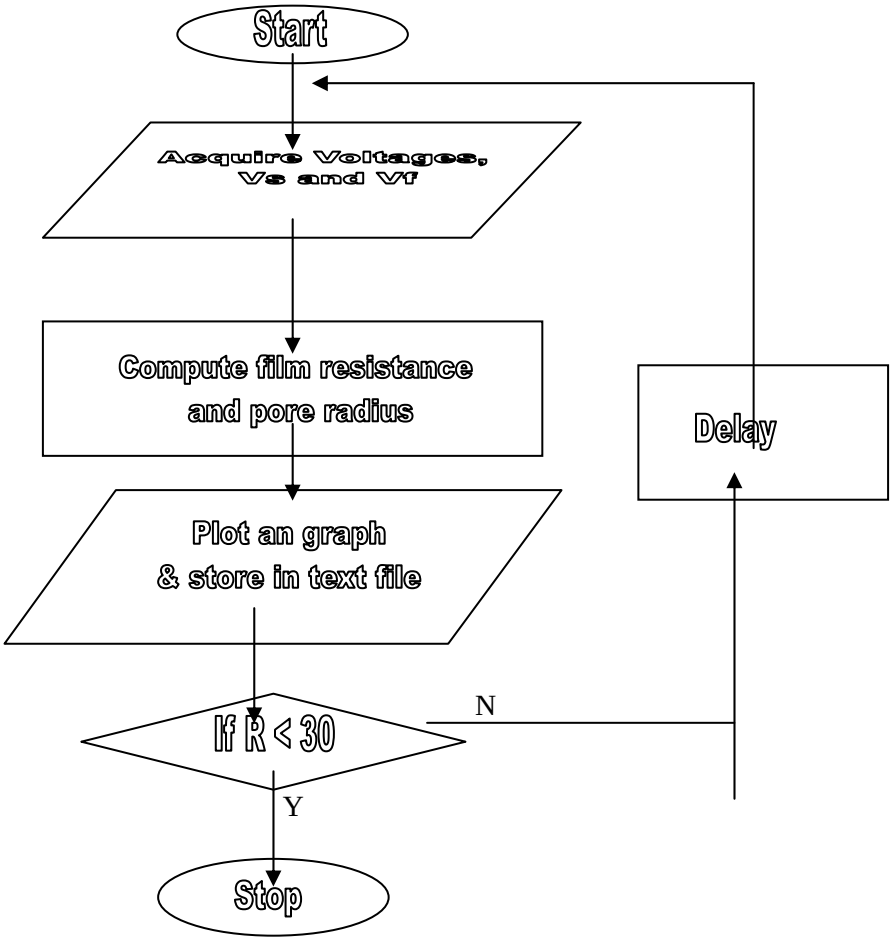

Fig. 2. Algorithm chart

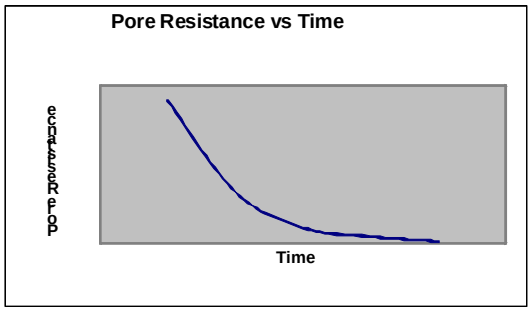

Fig. 3: Pore resistance vs Time

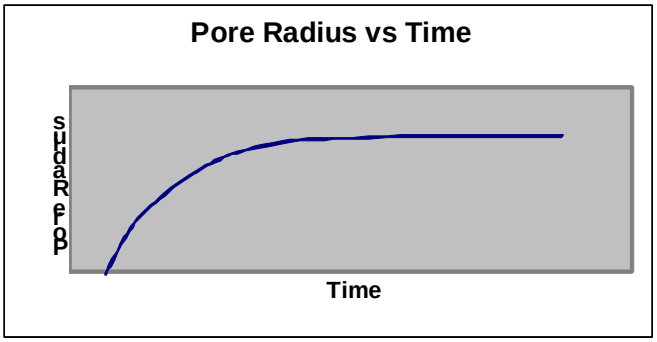

Fig-4 Pore radius vs Time

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