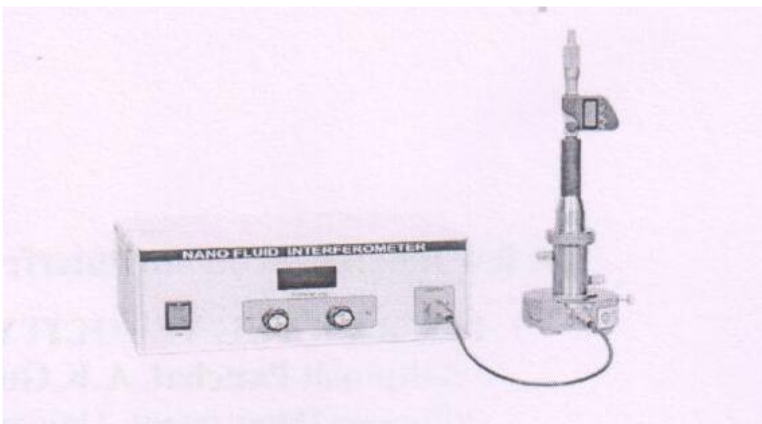
INSTRUCTIONAL MANUAL

NANO FLUID INTERFEROMETER



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Nano Fluid Interferometer

EXPERIMENT: To measure velocity of ultrasonic in nanofluids (Ag/Au/Cu nanoparticles) and to study the effect of temperature on velocity in nanofluids of different concentrations using nanofluid interferometer.

WORKING PRINCIPLE

Nanofluid Interferometer generates sound waves in nanofluids of different concentration at different temperatures. It is an alternate test instrument for study of nanofluid compressibility and inter molecular interactions with temperature variations. In this instrument ultrasound waves of known frequency are produced by a Piezo-electric transducer and its wave length is measured using digital micrometer with high accuracy within ± 0.001 mm.

From the knowledge of frequency (f) and wave length (λ), the compressibility of nanofluid is determined by the following formula:

Sound velocity in nanofluid, $V = \lambda \cdot f$

Adiabatic compressibility, $\beta_{ad} = (\rho \cdot V^2)^{-1}$, where ρ is density of the nanofluid.

Surface Tension (S) is determined by the following formula:

$$V = (S/6.3 \times 10^{-4}\, \rho)^{2/3}$$

DESCRIPTION

The Nanofluid interferometer consists of the following parts:

i) Wave Generator

ii) Nanofluid Cell

iii) Temperature Controller Unit. (RT - 90)

iv) Nanofluids – 3 samples.

Figure 1 shows the cross-sectional view of location of ultrasonic wave generator and liquid cell.

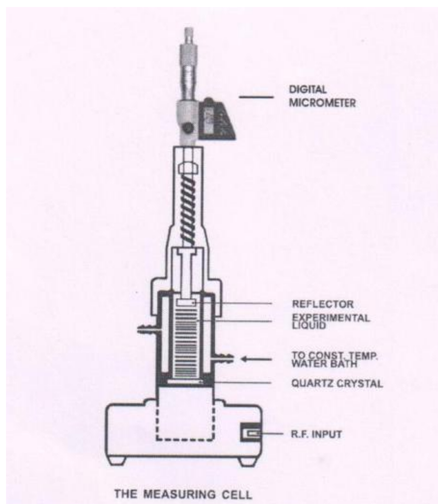

Fig 1. Cross-Section of the Liquid Cell

PROCEDURE

a) <u>Measuring Velocity of Ultrasonics in Nanofluid</u>

1. Remove the top reflector assembly from the nanofluid cell. Pour experimental liquid into cell and screw the knurled cap.

   Important: Liquid should be filled, while keeping the cell out of the circular base. Wipe out excess liquid overflowing from the cell.

2. Insert the cell in the base and tight it with the side screw provided.
3. Connect the base to the wave generator by co-axial cable provided with the instrument.
4. Keep the R_1 at middle approx and R_2 knobs at maximum position. Now move the micrometer slowly in either clockwise or anticlockwise direction. Digital micro-meter will show change in reading. If reading shows minus reading, it may be shifted to plus with the help of R_2 knob.

   Note: If micrometer head is locked, rotate the knob above display anticlockwise to unlock the micrometer head.

5. Note the readings of micrometer corresponding to the maximum in digital micro-ammeter. Take about 20 readings of consecutive maximum and tabulate them as shown below:

S.No.	Micrometer Reading corresponding to maximum (in mm)	Difference between consecutive maxima ($\lambda/2$)
1.	N1	
2.	N2	N2 – N1
3.	N3	N3 – N2
-		
-		
20.	N20	N20 – N19

Alternate Method: To determine wavelength (λ) of ultrasonics, alternatively note the readings of digital micro-ammeter corresponding to micrometer readings in a regular interval and plot the graph between position of reflector (micrometer reading) and crystal current (micro-ammeter reading). From the graph determine the value of $\lambda/2$ by taking the difference of consecutive maximas as shown in Fig. 2.

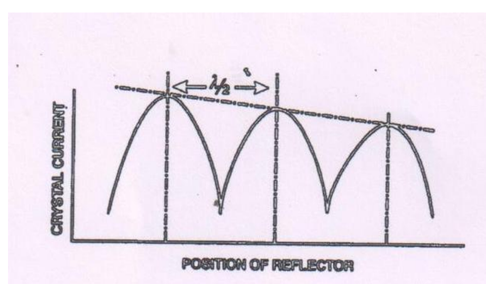

Fig. 2 Position of Reflector vs Crystal current

6. Take average of all the differences (λ/2).
7. Once the wavelength (λ) is known the velocity (v) of ultrasonic in the given liquid of known concentration can be calculated with the help of the relation

$$V = \lambda \times f$$

b) <u>Effect of temperature on velocity in nanofluid of different concentration</u>.

To study the effect of temperature on velocity in nanofluid, vary the temperature of fluid by passing hot water at different temperatures through of the liquid cell at given concentration and hence determine the velocity at different temperature using the procedure described above.

Further, to study the effect of nanoparticle concentration on ultrasonic velocity in the given fluid, vary the concentration of the fluid by known proportion and determine the velocity using the above procedure. Also effect of temperature on sound velocity for fluids of different concentration can be studied as depicted in Fig. 3 and 4.

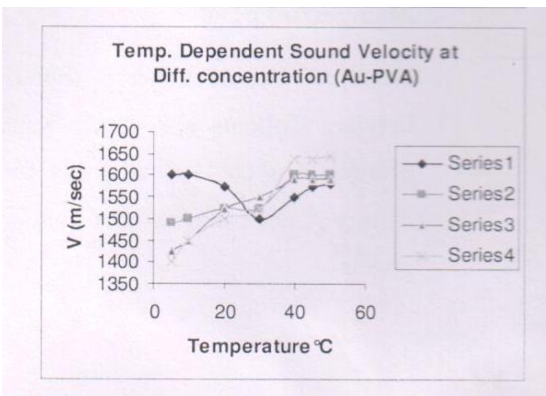

Fig. 3

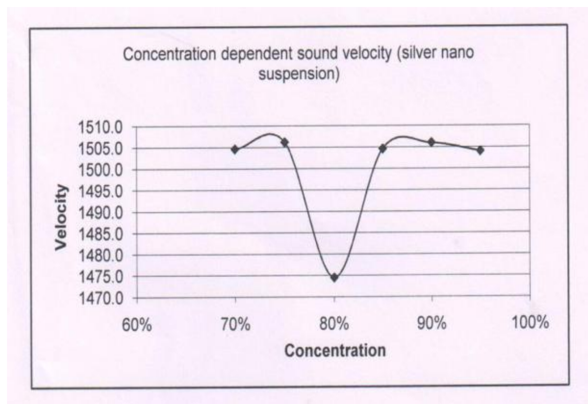

Fig. 4

<u>Sample readings for effect of Temperature and Concentration on Sound Velocity.</u>

Temperature (^{o}C)	Sound Velocity (m/s)
10	1400
20	1540
30	1580
40	1610
50	1620
60	1632

Concentration (%)	Sound Velocity (m/s)
70	1504.6
75	1506.2
80	1474.5
85	1504.6
90	1506.0
95	1504.0

Precautions:

A. Do not switch ON the wave generator without filling the experimental liquid in the cell
B. Remove experimental liquid out of cell after use. Use acetone for cleaning the Cell. No mechanical cleaning should be done. Keep the cell cleaned and dried.
C. Avoid sudden rise or fall in temperature of circulated liquid to prevent thermal shock to the quartz crystal.
D. While cleaning the cell care should be taken not to spoil or scratch the gold plating on the quartz crystal.
E. Give your generator 30 seconds warming up time before the observation.

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