Chapter 5

Conclusions

1. Conclusions

This thesis is centred around the piezoelectric, the pyroelectric properties and the thermal diffusivity of the composite. The 1-3 composites PZT/epoxy having 0.4 and 0.6 volume fraction of ceramic were fabricated by dice-and-fill technique. And 0-3 composite PZT/P(VDF-TrFE) having 0.3 volume fraction of ceramic were prepared by mixing the copolymer and the PZT powder.

Using the interferometric technique, it was found that the piezoelectric coefficient d_{33} of the 1-3 composite PZT/epoxy having 0.4 and 0.6 volume fraction of ceramic in frequency range 1-5 *kHz* were $190 \pm 10\ pm/V$ and $188 \pm 10\ pm/V$, respectively. And the piezoelectric coefficient d_{33} of the PZT in the same frequency range was $360 \pm 10\ pm/V$.

The pyroelectric coefficients of the composites were measured using the method of Byer and Roundy. The value of the pyroelectric coefficient of the composites having 0.4 and 0.6 volume fraction of ceramic and the PZT were found to be 44 $\mu C/m^2\ {}^{\circ}C$, 54 $\mu C/m^2\ {}^{\circ}C$ and 74 $\mu C/m^2\ {}^{\circ}C$, respectively.

The thermal diffusivity measurements are also carried out by using the method developed by Muensit and Lang (Muensit and Lang, in press). The measurements were made on the 1-3 composite PZT/epoxy in both 0.4 and 0.6 volume fraction of PZT, 0-3 composite PZT/P(VDF-TrFE) and epoxy by using $LiTaO_3$ as a detector. The phase retardation of the temperature waves passing through the composites and the pyroelectric current from the detector were obtained. The heat capacity of the composites was investigated using a Differential Scanning Calorimeter. In order to calculate the value of the thermal diffusivity of the composites, the phase retardation at the test frequencies corresponding to the volumetric heat capacity (ρc_p)

of the composite were analyzed by the Mathematica program. From the data analysis, it was found that the value of the thermal diffusivity were $2.24\times10^{-7}\,m^2/s$ and $1.43\times10^{-7}\,m^2/s$ for the 1-3 composite PZT/epoxy having 0.4 and 0.6 volume fraction of ceramic respectively, $2.5\times10^{-8}\,m^2/s$ for epoxy and $2.04\times10^{-8}\,m^2/s$ for 0-3 composite.

Finally, the thermal diffusivity of the $LiTaO_3$ was obtained by using the 1-3 composite as a detector. Using the similar way of calculation, the thermal diffusivity of the $LiTaO_3$ was $4.39\times10^{-7}\,m^2/s$. Table 5.1 summarizes the experimental results observed in the present work.

Table 5.1 All of the experimental results observed in the present work.

Material	ϕ	ρ g/cm^3	c_p $J/kg\cdot K$ at 25 °C	d_{33} pm/V	p $\mu C/m^{2o}C$	α $\times10^{-7}\ m^2/s$
1-3 composite PZT/epoxy	0.4	3.74	214	190	44	2.24
	0.6	5.06	283	188	54	1.43
PZT	1.0	7.70	420	360	74	-
0-3 composite PZT/P(VDF-TrFE)	0.3	1.88	2753	-	-	0.20
Epoxy	0.0	1.10	2777	-	-	0.25
$LiTaO_3$	-	7.46	429	-	-	4.39

From the investigation, 1-3 composite PZT/epoxy is promising for applications as pyroelectric detector and transducer. For 0-3 composite PZT/P(VDF-TrFE) the poling process was incompleted because of the damages of the sample during the process.

2. Suggestions and Further Investigations

1. In the measurements of the d_{33} coefficient, a sample must be rigidly mounted to avoid vibrating of a substrate.
2. In the measurements of p coefficient, it is necessary to ensure that a temperature change is uniform.
1. In the measurements of the α value, the layer of the cement glued between the test sample and the detector must be sufficiently thin.
4. To enhance the poling efficiency, the corona poling is recommended. The necessity of electrodes on the samples and the possibility for break down are the disadvantages of the poling method. Corona poling[3] is one of the alternatives for overcoming these problems.

For further investigation, it is of very interested in studying the properties of the detector made from the composite such as the responsibility, time constant, noise, power and reliability.

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[3] In the corona poling, the non-metallised surface of a sample is exposed to a corona, which is usually generated by a needle or wire electrode. The sample is exposed to the corona for a periods of several second up to minutes a room temperature or elevated temperautre.