Modified Acrylamide Polymer as Piezoresistive Sensing Material

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Abstract: In this study, making the acrylamide polymer more sensing was investigated. Resistivity was identified as the sensing parameter. By adding 1% conductive filler the resistivity of polymer was increased by 22% at 16 psi.

1. Introduction

Emerging construction applications require materials to be sensitive to the changes happening inside, in order to address safety and environmental issues. This smarter behavior is known as self-sensing ability. Piezoresistivity describes change of electrical resistivity of a composite with applied stress (or Strain). Piezoresistivity has been proven to be a good sensing property in the literature (Carmona et al.(1987), Vipulanandan and sett (2003), Todoroki et al. (2009) and Masoud et al.(2012). It can be used to self-sense stress/strain, sense damage and thermoelectric properties and monitor health of the structure and more. Modified acrylamide polymer, which behaves more like a sensor, will be an enhanced outcome for construction industries to respond to extreme challenges in civil and material industry.

2. Objective

The overall objective was to make the acrylamide polymer more sensing. The specific objectives are as follows:

1. Identify the parameters to monitor the performance of the acrylamide polymer and
2. Investigate the Piezoresistive behavior of pure acrylamide polymer and modified acrylamide polymer.

3. Materials and Methods

In this study acrylamide polymer grout was modified with 2% Salt (NaCl) and 0.1% Conductive filler to investigate the piezoresistive behavior. After mixing the grout electrical resistivity was measured for 2 hours by using conductivity meter. In order to quantify the Piezoresistive behavior compression test was performed. During compression test, electrical resistance was measured in the stress axis. Alternating current (AC) resistance measurements were made using a LCR meter at a frequency of 300 kHz. Furthermore, changes in resistivity were related to the applied stress. Impedance spectroscopy method was used to investigate the sensing behavior of the acrylamide polymer. (Vipulanandan and Prashanth.,2013).

4. Results and Discussion

The impedance frequency response of polymer with and without conductive filler showed resistivity as the material property as shown in Fig.1. As shown in Fig.2, the setting time was indicated by the variation in resistivity value. Initially the resistivity increased to 1.5 times when setting then continued to slightly decrease thereafter. Change in electrical resistivity is same as change in electrical resistance for same specimen. Total change in resistivity was calculated as the cumulative change in resistivity ($\Delta\rho/\rho0\%$) of each small increment ($\Delta\sigma11$). Figure 3 shows the piezoresistive behavior of pure polymer and modified polymer with 2% NaCl and 0.1% Conductive filler. Addition of salt with polymer increased the piezoresistivity behavior from 8.5% to 12%. piezoresistivity of smart polymer grout at 16 psi compressive stress was 21% .

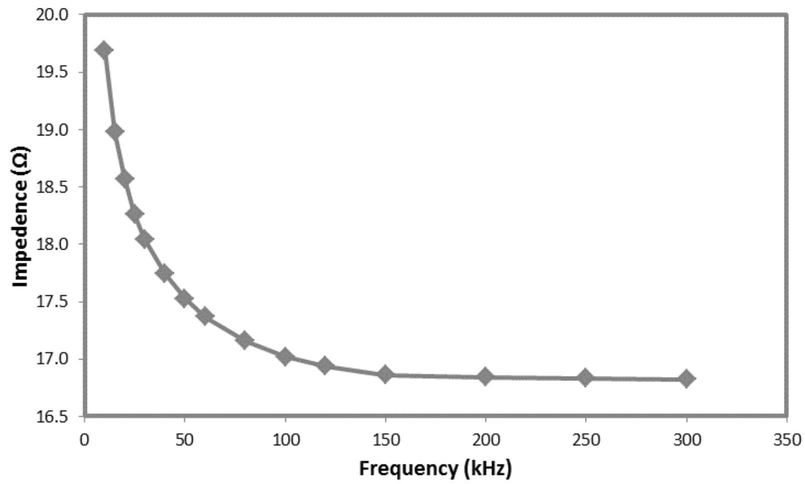

Figure 1: Impedance Behavior of Acrylamide Polymer

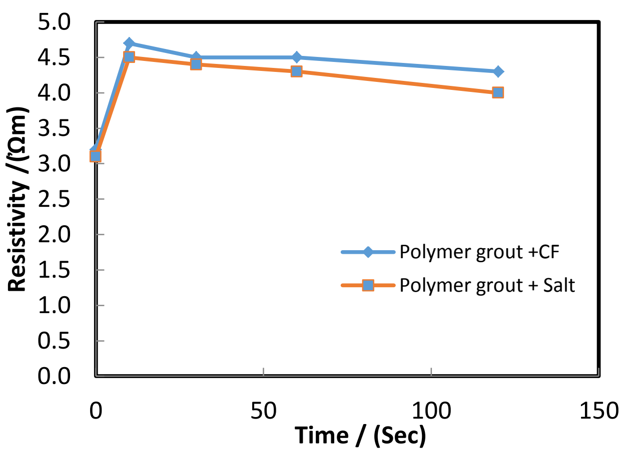

Figure 2: Resistivity with time for acrylamide polymer

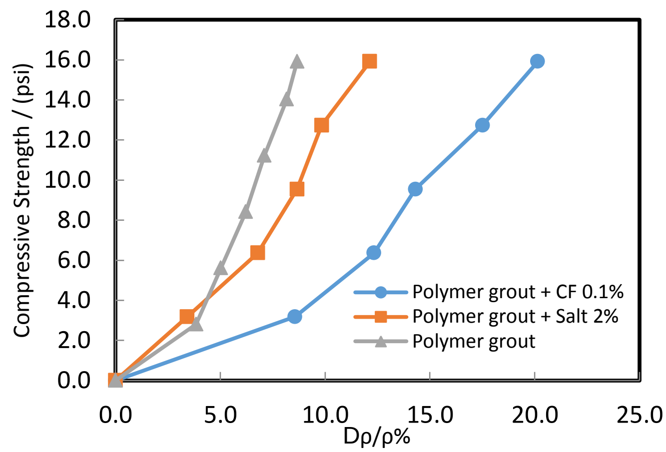

Figure 3: Piezoresistive response of the smart polymer grout after 1 day of curing

5.

Conclusion

• Setting time of acrylamide polymer is indicated by increase in resistivity. When the polymer grout hardened 1.5 times increase in resistivity value over the initial resistivity during mixing was observed.

• The resistivity change of the polymer grout increased from 8.5% to 12.1% with 2% addition of salt and with 0.1% CF the piezoresisitivity of the smart polymer grout was 21% at 16 psi compressive stress.

6. Acknowledgements

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7. References

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