SENSING PROERTIES OF EPOXY RESIN/SPRAYED CARBON BLACK CONDUCTIVE COMPOSITES

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Introduction

Intelligent health monitoring for civil infrastructure is more effective to ensure the structural safety in service. Recently many kinds of smart sensors have been developed. However, this topic on smart materials and sensors is still on-going. The electromechanical properties of CB(carbon black)/polymer conductive composites are excellent and may provide a potential way to develop smart sensors. Kost *et al* (1983,1984)[1,2] have studied the electromechanical properties of CB/rubber conductive composites under static loading and cyclic loading conditions. However, it is limited on implementation in health monitoring for civil infrastructure because Young's modulus of CB/rubber conductive composites is small, and fractional change in resistance was also small when applied strain is small, it is not available to monitor health of infrastructure. Sprayed CB/epoxy resin conductive composites are developed and their electromechanical properties are experimentally studied under static loading and cyclic loading conditions.

Experimental

Materials

Epoxy resin used in the test is E-51, which bought from ShenZhen Kunzhan Industrial Ltd, China. Sprayed CB is obtained from ShanDong LinZi HuaGuang Chemical Industry Plant,China.

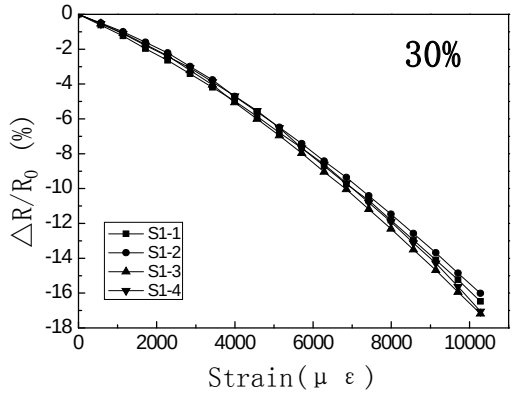
The specimens containing 15%, 20%, 25% and 30% CB by weight were prepared. The size of cubic specimen is 50×50×50mm.

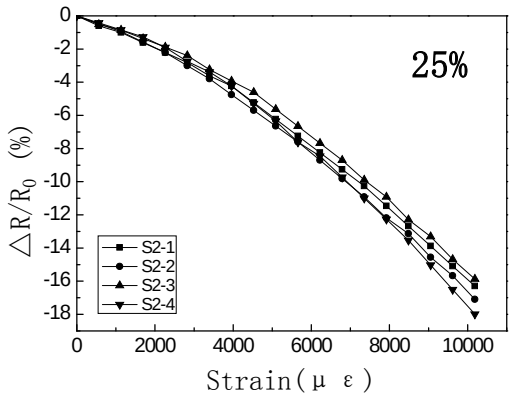
Test procedure

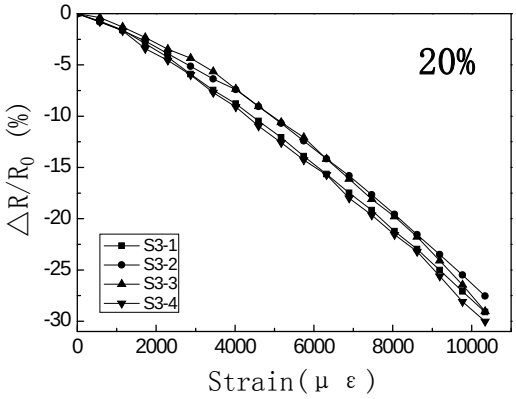
Compressive testing under load control is performed using a hydaulic mechanical testing system (MTS) with 120kN maximum loading capacity. During compressive testing, DC electrical resistance measurement is made in the stress axis, using the two-probe method. A FLUKE8842A multimeter is used to measure the resistance and current of the specimens.

Results and Discussion

The relationship of change in resistance and strain is showed in Fig.1 and change in resistance and circular loading showed in Fig 2. (denoted by $\Delta R/R_0$, ΔR is the variation of electric resistance and R_0 is the initial electric resistance).







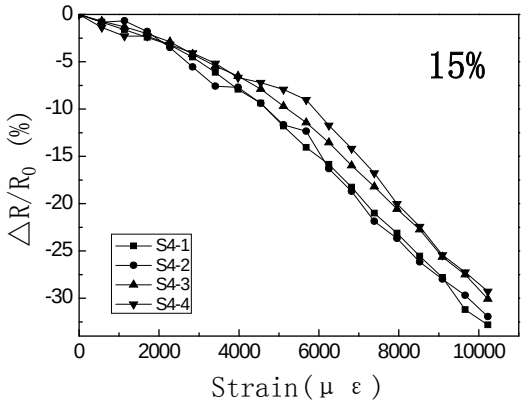


Fig1. Relationship of change in resistance and static loading

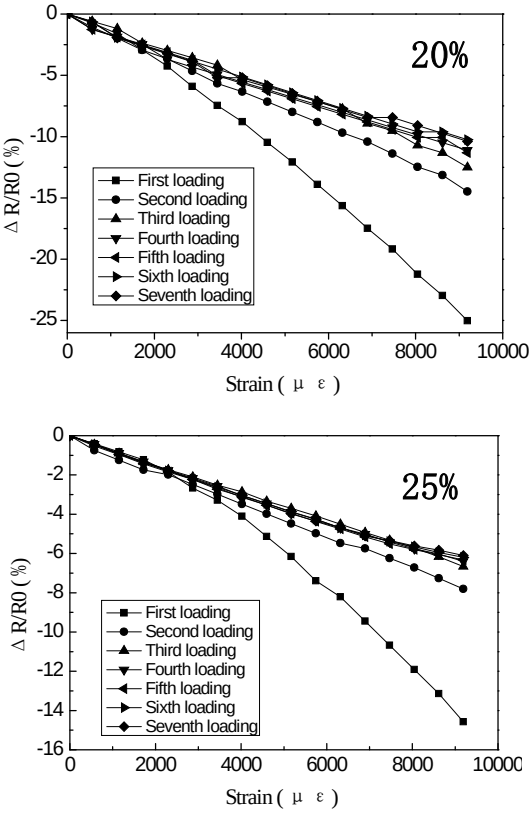


Fig2. Relationship of change in resistance and circular loading

Fig1 shows that the value of ΔR increases with the decreasing of CB concentration. But the stability of resistance changes with static loading shows an adverse relationship. From Fig2 we can see that the value of ΔR decrease with the increasing of cycling number and then reach to a stable value after several cycles. The residual electric resistance is found after unloading, however, it is smaller and smaller with the increasing number of loading cycles, and finally to zero as shown in Fig3 (denoted by $\delta R/\Delta R$, where ΔR is the variation of electric resistance and δR is the residual electric resistance.) So the epoxy resin/sprayed CB conductive composites can be used as smart monitoring materials after being treated by the pr-circular loading means.

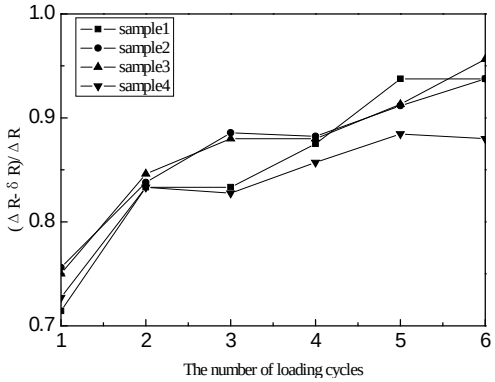


Fig3. Resistance recovery ratio of the sample containing 20% carbon black after unloading

Conclusion

The sensing properties of epoxy resin/spray CB conductive composites were experimentally studied. The results indicate that the relationship of fractional change in resistance and applied stress is stable and sensitive. The conductive composites can be used as smart monitoring materials after being treated by the pr-circular loading means.

Reference

1. Kost J, Nsrkis M and Foux A. Effects of axial stretching on the resistivity of carbon black filled silicone rubber. Poly. Eng. Sci. **23** (1983) 567-571.
2. Kost J, Nsrkis M and Foux A. Resistivity behavior of carbon black filled silicone rubber in cyclic loading experiments. J. Appl. Poly. Sci. **29** (1984) 3937-3946.