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New Composite Material Based on Graphite Microparticles in Glassy Matrices for Applications in Piezoresistive Sensors

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INTRODUCTION

Results of development of a new low cost piezoresistive composite material for use in pressure sensors are presented. Usually, piezoresistive sensors are fabricated using high sintering temperature glassy matrixes (frits) and conductive metal oxides like ruthenium oxide [1]. Here, the piezoresistive material is composed by porous glassy matrix with graphitic particles (~ 3 µm lateral dimension) as a conductive filler.

A new methodology for producing piezoresistive films from pastes prepared using a frit powder, micrographite particles and an aqueous phase of sodium carboxymethyl cellulose (CMC) was developed. The resistances of films (with lateral dimensions of 50 x 5 mm) were measured to vary between ~ 1.2 and 142 kΩ, depending on composition.

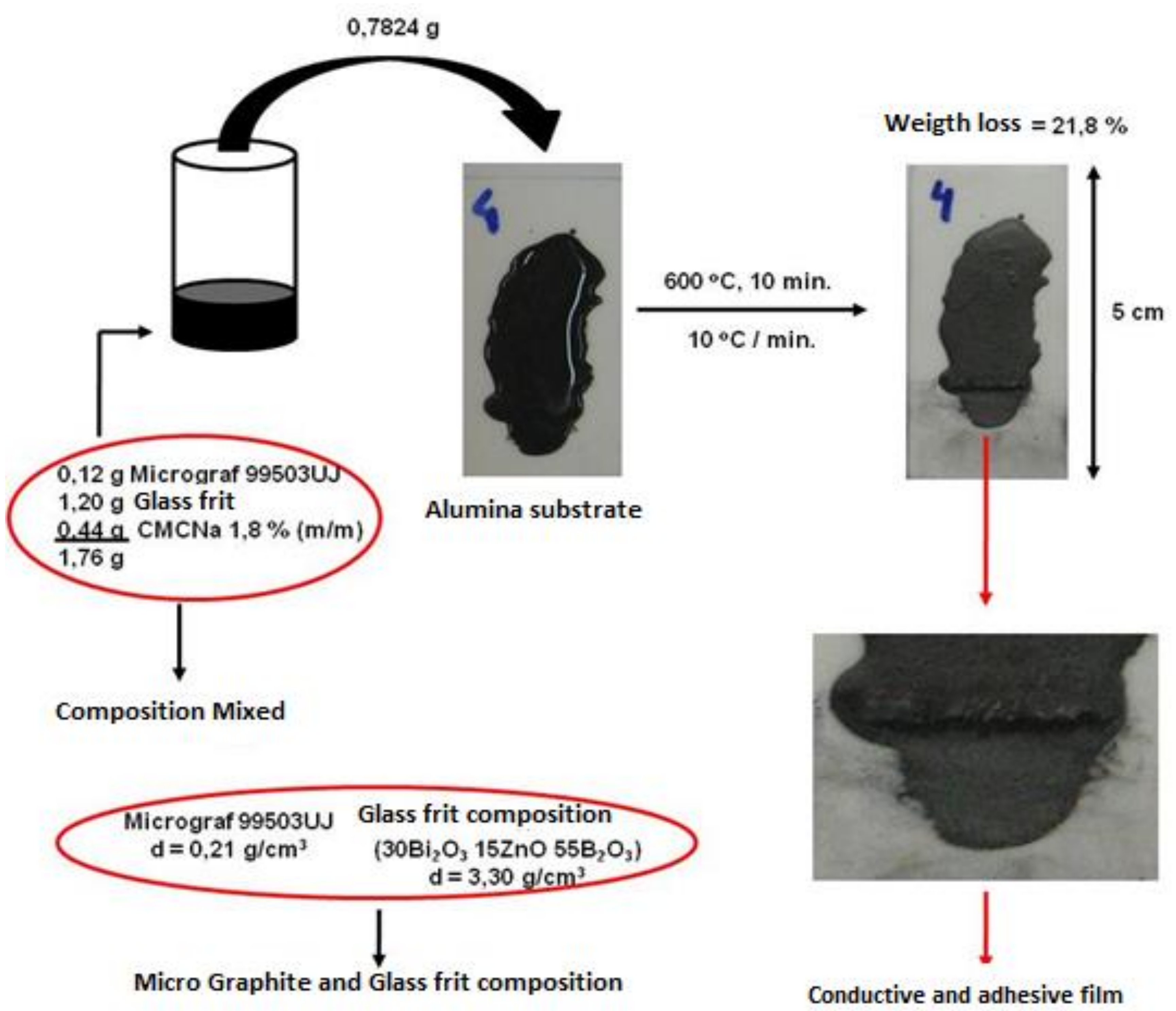
The preliminary results showed that low-cost micrographite particles can replace expensive metal oxides like RuO_2 in piezoresistive sensors with comparable performance.

MATERIALS AND METHODS

Several different frit compositions (consisting of oxide mixtures $PbO/ZnO/SiO_2/Al_2O_3$, $Bi_2O_3/B_2O_3/ZnO$ and $Bi_2O_3/B_2O_3/SiO_2/Al_2O_3/ZnO$) were developed and tested to provide low sintering temperatures (down to 600°C) in order to prevent burning of micrographite during final composite preparation [2]. The conductive pastes were prepared by mixing micro graphite particles with the glass frit and a solution of CMC Na (2%) in deionized water at room temperature, until reaching a paste viscosity consistency. The developed pastes were applied on alumina substrates by the screen printing process.

RESULTS AND DISCUSSION

Figure I below shows the process of the paste development.



The process of frit preparation

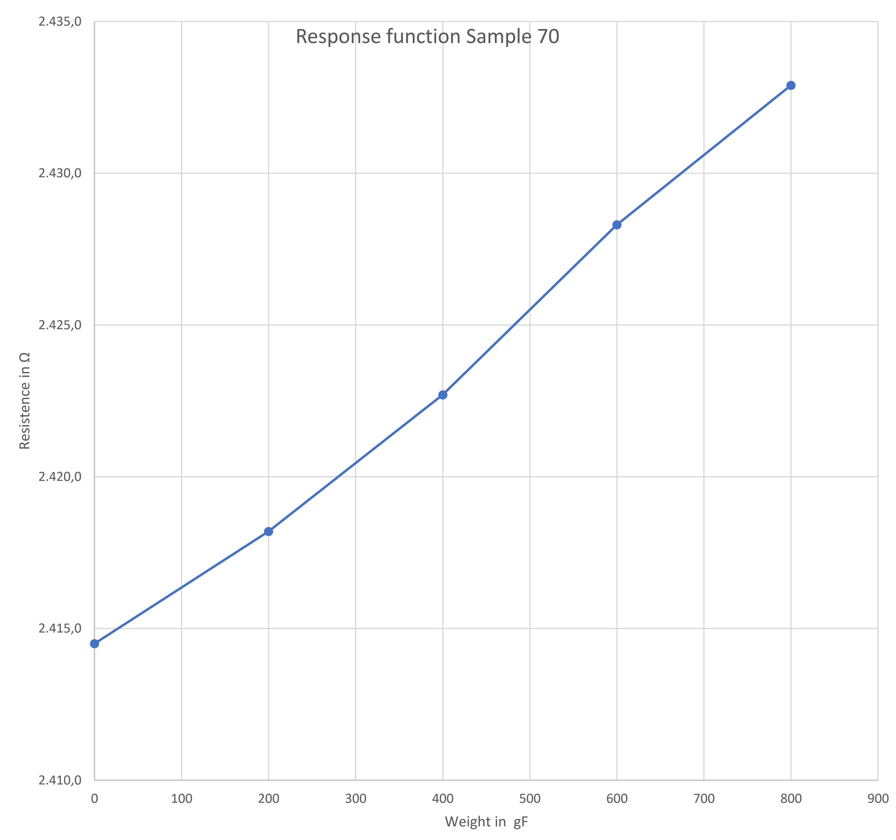
The frit composition

Glass Matrix ($20Bi_2O_3$ $43B_2O_3$ $25SiO_2$ $2Al_2O_3$ $10ZnO$)					
Composition	% Mol	Mol (g/Mol)	Weight (g)	No. of Mol	Molar Fraction
Bi_2O_3	20	465,96	9,42	0,020	0,20
B_2O_3	43	69,61	3,03	0,043	0,43
SiO_2	25	60,08	1,51	0,025	0,25
Al_2O_3	2	101,96	0,21	0,002	0,02
ZnO	10	81,39	0,82	0,010	0,10
Total	100			0,100	1,00

Response of the sensor to loading

Sample 70	
Weight (gF)	R (Ω)
0	2.414,5
200	2.418,2
400	2.422,7
600	2.428,3
800	2.432,9

Linear sensor response with loading can be confirmed ⇒



CONCLUSIONS

The preliminary results show that low-cost micrographite particles can replace expensive metal oxides like RuO_2 in piezoresistive sensors with comparable performance.

An important role of CMC in providing the paste homogeneity and good adherence of graphitic layers to glassy matrix was confirmed. The paste based on $Bi_2O_3/B_2O_3/SiO_2/Al_2O_3/ZnO$ was proved to be the most stable under multiple flexure tests and it was successfully tested in piezoresistive sensors.

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