O-34

Electromagnetic MEMS motors for display technologies

I.Timoshkov[2], V.Kurmashev[1], D.Grapov[2], A.Vetcher[3], G.Govor[3]
[1]Belarusian State Academy of Communications, Minsk, Belarus
[2]Belarus State University of Informatics and Radioelectronics, Minsk, Belarus
[3]Scientific Practical Materials Research Center of National Academy of Science, Minsk, Belarus

1. Introduction

The fourth revolution of the industry is powered by a wide range breakthrough, new technology, innovative ideas and creative activities. All these things were naturally born, mostly, by the interdisciplinary science and technology. Soft magnetic composites are the bright example of the different technologies integration to get final commercial technologies to get the final products with enhanced properties. Micro displacement and micro positioning became a very important factor for new display technologies such as ink jet, 3D printing, nanoimprint. New generation of technologies allows increasing productivity and improving quality. MEMS micromotors are the core of such instruments for display production.

2. Soft magnetic composite for MEMS micromotors

In the report we systematized the methods, technologies and structures of heterogeneous materials with soft magnetic properties, pros and cons are discussed. The main mechanisms of magnetization reversal of such structures are reviewed, as well as the effect of inhomogeneities on the main magnetic properties: magnetic induction, permeability, coercive force, and loss. The basic requirements to these materials for practical use in electromagnetic systems are analyzed.

We developed the technology of iron powder treatment to create the nanometer coating on the surface of each particle. The final magnetic details are produced by technology of powder metallurgy with macro and micro moulds. Unique specific parameters of a soft magnetic composite material were achieved: magnetic induction of saturation – 2.1 T, working frequency range - up to 1 MHz, permeability – up to 1000, total loss – 8 W/kg, Curie temperature - above 800C. These allow to produce machines with the large number of poles and high frequency of switching, thus improving specific mass and size parameters. UV -LIGA MEMS technology combined with electroplating was developed to produce hybrid stepper micromotor based on soft magnetic composites. The technology part was successfully tested with two types of thick film photoresists: SU-8 liquid photoresist (electroplating forms are reusable up to 10 times), dry film photoresist (provides cheap and scalable production). Photoresist film thickness was 50-1000 μm. Glass high resolution photomask or affordable polymer flexible film photomask are both applicable for this technology.

Electroplating allows deposition of conductive amorphous alloys based on metals like Fe, Ni, Co with additives like B, P. Special process was developed to allow insertion of conductive powder filaments into soft magnetic matrix formed by plating. Special surface chemical treatment is used to reduce adhesion of electrodeposited part to substrate. It provides easy removal of part from photoresist-based microform.

Described technology is suitable for the following applications for display production equipment:

- manufacturing of microforms for micropressing technology;
- mechanical parts manufacturing – gears, racks etc;
- magnetic cores manufacturing;
- stators and rotors for BLDC and stepper motors (including linear). Combination of soft and hard magnetic materials in one process/design.

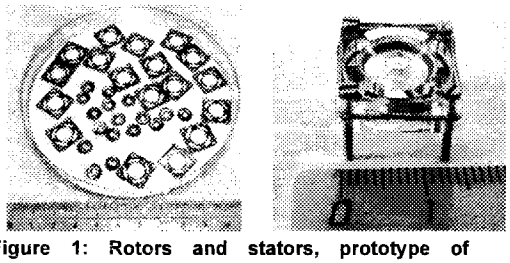

Figure 1: Rotors and stators, prototype of micromotors

3. References

[1] I. Timoshkov, Q. Gao, G. Govor, A. Sakova, V. Timoshkov, and A.Vetcher "Nanomodified composite magnetic materials and their molding technologies" , AIP (American Institute of Physics) Advances (Vol.8, Issue 5, 2018