Available online at www.sciencedirect.com

ScienceDirect

Procedia Manufacturing 13 (2017) 402–409

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

Manufacturing Engineering Society International Conference 2017, MESIC 2017, 28-30 June 2017, Vigo (Pontevedra), Spain

Design and manufacture of structured surfaces by electroforming

P.M. Hernández-Castellano[a,*], A.N. Benítez-Vega[a], N. Díaz-Padilla[a], F. Ortega-García[a], P. Socorro-Perdomo[a], M.D. Marrero-Alemán[a], J. Salguero[b]

[a]*Integrated & Advanced Manufacturing research group. Integrated Manufacturing building, Parque Científico-Tecnológico ULPGC. Campus de Tafira. Las Palmas de Gran Canaria 35017, Spain*
[b]*Engineering & Technology of Materials & Manufacturing research group. Faculty of Engineering. Avda. de la Universidad de Cádiz, 10. Puerto Real (Cádiz) E11510, Spain*

Abstract

Functional surface texturizing is increasingly demanded by multiple industrial sectors because it allows to achieve properties that significantly improve the functional characteristics of many products. The surfaces structured with geometric details at micrometric scale are allowing a selective modification of their properties. The electroforming process is acquiring a major role in the manufacture of microstructures, due to its great capacity for reproduction of details. The University of Las Palmas de Gran Canaria has extensive experience in rapid tooling through the electroforming process and is collaborating with the University of Cádiz in the ELECTROTEX project to Study of the Tribological Behaviour of Textured Surfaces by SEDM. This collaboration consists of the development of a SEDM electrode with a structured surface for the machining of test specimens for tribological tests.

© 2017 The Authors. Published by Elsevier B.V.
Peer-review under responsibility of the scientific committee of the Manufacturing Engineering Society International Conference 2017.

Keywords: Texturing; Structured surfaces; Electroforming; EDM.

1. Introduction

Surface engineering is currently playing a key role in the development of many industrial applications, among other things, a geometric selective surface modification of a product improves the functional properties. The functional

* P.M. Hernández-Castellano.
E-mail address: pedro.hernandez@ulpgc.es.

2351-9789 © 2017 The Authors. Published by Elsevier B.V.
Peer-review under responsibility of the scientific committee of the Manufacturing Engineering Society International Conference 2017.
10.1016/j.promfg.2017.09.030

texturing can be achieved by applying a given geometric pattern, micrometer scale and both low relief and over-relief extended to the surface on which you want to alter their behavior, resulting in so-called structured surfaces. Properties such as adhesion, friction coefficients between the surfaces and behavior in contact with different types of fluids, are clear examples of their applications. Furthermore, they have the advantage that they are easily replicated using traditional mass production processes in polymeric materials such as injection molding, hot embossing, and lithographic printing. Actual uses of these micro-structured surfaces are already in the fields of microelectronics, information and communication technologies, tribology, biomedicine, automotive, aerospace, optics, energy, mechanics, thermodynamics, hydrodynamics and coatings. In this context, surface engineering presents a situation of intense expansion continually extending their fields of application.

This work is part of the ELECTROTEX project Study of the Tribological Behaviour of Textured Surfaces by Seed Electro-Discharge Machining (SEDM), which is developing the Engineering & Technology of Materials & Manufacturing research group (INTEMAFA) of the University of Cádiz (UCA) and which is collaborating at the University of Las Palmas de Gran Canaria (ULPGC) through Integrated & Advanced Manufacturing research group. The work package in this project is the development of an SEDM electrode, for use in functional textured surfaces with tribological applications, using the electroforming process. The basic objective of this work is to perform the design of this tool and expose the manufacturing stages required by the electroforming process.

2. Background

In this section a brief description of the state of art and previous experiences related to the electroforming process and the structured surfaces will be made.

2.1. Electroforming

Electroforming is defined as the production or reproduction of articles by electrodeposition upon a mandrel or mold that is subsequently separated from the deposit, according to ASTM B832-93 “Standard Guide for Electroforming with Nickel and Copper”. This electrolytic process has been known for a long time, but has become especially interesting in recent decades. Its main fields of application are the manufacture of grid products such as plates or printing cylinders, to radar waveguides, micro components for medical, optical or mechanical applications and tools for other manufacturing processes [1]. The most important capabilities of electroforming are the ability to reproduce even the smallest details of a surface and very accurately, and strict control over the physical and mechanical properties of the electroformed part by selecting the composition of the electrolytic baths and process parameters.

Electroforming involves the electrolytic deposition of a metal layer from the dissolution of an electrode of this metal which is the anode of the system, on an electrode model that will constitute the cathode of the system. Continuous current is applied between the anode (+) and the cathode (-) with the entire system immersed in an appropriate solution or bath of metal salts with the two submerged electrodes. When the current flows through the circuit, the metal ions present in the solution are converted into atoms that are deposited on the conducting surfaces of the cathode, creating a more or less uniform metal layer or shell [2]. Therefore, electroforming can be considered as an ionic additive manufacturing process where the material is deposited in layers which do not have to be flat.

The main limitations of this process are a low deposition rate, almost exclusive application to thin-walled products, and the need for electrically conductive models on their active surfaces. None of them significantly affects the manufacture of micro-shells with high dimensional accuracy, precise reproduction of surface details and fabrication of components of complex and thin-walled geometries. Therefore, the electroforming process has great advantages in the field of micro-manufacturing.

In fact, a variant of the process specifically directed to the microfabrication of components called micro-electroforming has emerged in recent years [3,4]. In this specific line, very good results have been obtained in obtaining metallic microstructures with electrolytes of nickel sulfamate, which allows deposits with relatively high deposition rates and low internal stresses [5,6]. In this variant special systems are used for electroforming equipment, such as pulsating energy sources with polarity inversion, magnetic and/or ultrasonic agitation systems, relative movements and orientation of the electrodes, in addition to the application of vacuum conditions during the process [7–11]. These systems allow a very specific electrodeposition adapted to the part geometry, modifying the crystalline

Download English Version:

https://daneshyari.com/en/article/5128556

Download Persian Version:

https://daneshyari.com/article/5128556

Daneshyari.com