Chapter 56
Research Perspectives on Functional Micro and Nano Scale Coatings:
New Advances in Nanocomposite Coatings for Severe Applications

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ABSTRACT

Research topics related to the production of nanocomposites are the most important directions of development of new semiconductor engineering, ensuring high nanocomposites obtaining useful properties in the scope of biophysical characteristics, biomedical and piezoelectric applications. We present two case studies as Hydroxyapatite are in medical applications and aluminum nitride as acoustic wave sensor. Hydroxyapatite, is the main inorganic structure of the tooth enamel and bone and is a biomaterial that is commonly used in biomedical applications that involve bone substitution, drug delivery and bone regeneration because of its excellent biocompatibility, high bioactivity and good osseoconductivity. Since the past decade. Aluminum nitride (AlN), an electrical insulating ceramic with a wide band gap of 6.3 eV, is a potentially useful dielectric material very important in fields such as optoelectronic and micro electronics.

INTRODUCTION

In recent years, there has been a breakthrough in the research of new materials with increasingly complex structures with properties of ionic and electronic conduction (Morkoc, 2013). Such materials have applications in important areas of technology as components of many optoelectronic devices - among the new materials studied highlights the metal nitrides - and hydroxyapatite nanostructured films fabricated by RF magnetron sputtering for biomedical applications (Zhang, 2013).

In general, semiconductor nitrides are the group of inorganic compounds consisting of nitrogen and other more electropositive element, except for halogens and hydrogen. Nitrides of elements such as boron, titanium, zirconium, aluminum, and silicon are hard, stable at high temperatures, and are resistant to chemical agents. At a much smaller scale, coatings are used in numerous electronic products (both consumer and industrial electronics) and biomedical products.

Currently, our society is increasingly immersed in nanotechnology. They are shown, two approaches to nanocoatings applications that impact our daily lives. In section 1, a new method of magnetic confinement of plasmas RF hydroxyapatite has shown to produce a high crystalline quality for biomedical applications. In section 2, aluminum nitride nanostructures grown via pulsed laser deposition - PLD that has been used as substrates for the manufacture of acoustic wave devices - SAW are highly demanded by the telecommunications industry.

1. HYDROXYAPATITE NANOSTRUCTURED FILMS FABRICATED BY RF MAGNETRON SPUTTERING FOR BIOMEDICAL APPLICATIONS

Hydroxyapatite - HA $(Ca_{10}(PO_4)_6(OH)_2)$,(Morgan, Wilson, Elliott, Dowker, & Anderson, 2000) is the main inorganic structure of the bone and enamel teeth and also is the main bioceramic that is commonly used in biomedical applications that involve drug delivery, (Hollister, 2005; Vallet-Regí & Ruiz-Hernández, 2011) bone repair and bone regeneration due its excellent properties of osteoinduction, osteoconduction and osseointegration (Astala & Stott, 2008; Paul & Sharma, 2006). Since past decades, the HA has been used as a bioactive coatings to improve the osteoconductivity of metallic implants for the orthopaedic applications. Metals as titanium and alloys have not the bioactive capacity, different deposition techniques to produce calcium phosphate (CaP) coatings has been developed to improve the osseointegration, osteoconduction and osteoinduction of the metallic implants (Dos Santos et al., 2010; Macaskie et al., 2005; Socol et al., 2004; Ueda, Narushima, Goto, Taira, & Katsube, 2007; Wang et al., 2006; Wen, Xu, Hu, & Hodgson, 2007).

Chemical and physical deposition processes are used to synthesize HA as coatings over a metallic surface, these deposition techniques are: biomimetics, (Uchida, Oyane, Kim, Kokubo, & Ito, 2004) sol-gel routes, (Melde & Stein, 2002; Padilla, Roman, Carenas, & Vallet-Regı, 2005; K. Zhang, Francis, Yan, & Stein, 2005) electrochemical deposition,(Liu, Savino, & Yates, 2011; Narayanan, Seshadri, Kwon, & Kim, 2008; Wang, Eliaz, & Hobbs, 2011) and others,(Li, Hong, Yu, & Qi, 2010; Li & Qi, 2008) as well as plasma spray, (Dong, Khor, Quek, White, & Cheang, 2003; Ellies, Nelson, & Featherstone, 1992; Khor, Dong, Quek, & Cheang, 2000) Pulsed Laser Deposition (PLD), (Carradò, 2011; Joanni et al., 2004) Ion and Electron Beam Deposition (IBD, EBD),(Jeong, Choe, & Eun, 2011; Rabiei et al., 2006) Electron Cyclotron Resonance deposition (ECR)(Akazawa & Ueno, 2013, 2014) and Radio Frequency Magnetron Sputtering (RF-MS) (Akazawa & Ueno, 2014; Boyd, Meenan, & Leyland, 2006). The chal-

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