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PIM-FCS: Advanced piezoelectric materials functionalized for the quality and security control of food

PROJECT DESCRIPTION

Food represents a major problem of great importance in any society and it has economic and social consequences, affecting human health and the environment. The food security concept regards to production and commercialization of food secure for the consumer, food that correspond to the quality and nourishing requirements, the final scope being health state maintenance.

Mycotoxins from food and agricultural products can be detected and analyzed by a bio-sensitive sensors based on piezoelectric materials. The most used piezoelectric materials for bio-sensitive sensors are quartz.

Although the quartz crystals are the most utilized piezoelectric materials, they have 3 major drawbacks from the applications point of view, as follows: low electromechanical coupling coefficient, k= 8 %, α-β phase transition at 573ºC temperature, quality factor Q starts to decrease below transition temperature.

The structural distortion of quartz structure can be described by two interrelated angles: the intertetrahedral bridging angle A-O-B, θ, and the tetrahedral tilt angle δ. For very well characterized crystals (SiO_2, $AlPO_4$ and $GaPO_4$), it proved possible to relate linearly their A-O-B values (143.7°, 142.8° and 134.6° respectively) to their piezoelectric properties such as coupling coefficient and the α-β transition. The more distortion structure, the more the θ and δ values decrease and increase, respectively. One of main way to obtain a more distortion structure, it is to increase the average size of ‹rA› of A-site cations.

This project proposes to develop a way to increase the structural distortion, using Ge and Sn to dope the SiO_2 structure thus to increase the performance of the bio-sensitive devices. Growth of this type of the crystal will be realized by hydrothermal method using high temperature (upon 500℃) and pressures (upon 2700 bars).

The objectives of the project are: (i) development of new advanced piezoelectric materials by complex methods: hydrothermal method using high pressures and temperatures; (ii) manufacture of new bio-sensitive devices; (iii) functionalizing and testing of the bio-sensitive devices and elaboration of comparative studies regarding their efficiency depending on physical and material characteristics.

The new bio-sensitive devices based on the advanced piezoelectric materials achieved in this project will be studied by comparative studies with bio-sensitive devices based on langasite. Langasite presents piezoelectric properties more superior than traditional materials, being a combination between piezoelectric properties of quartz and lithium tantalate. Langasite do not present any phase transformation till melting temperature, 1470℃, while quartz present a phase transition at 573oC.

Potential users of the project results can be any company from food and agriculture industry. The manufacture and characterization of biosensors based on new advanced piezoelectric materials achieved in this project presents a major problem on the world level, because this kind of biosensors have multiple applications in chemistry, biochemistry, medicine, technological and biotechnological processes control.

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PARTNERS

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ROM-QUARTZ Bucharest, **Romania**
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PROJECT DURATION AND TOTAL PROJECT COST:

Duration: 01/2010-01/2012
Cost: 351.000 €

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