ECONOMIC ASSESSMENT OF NITRIDE CERAMIC APPLICATIONS IN AEROSPACE HIGH-FREQUENCY TECHNOLOGY

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Modern radio communication and radar systems, particularly in the aerospace and defense sectors, demand the use of radio-transparent structural materials that offer high thermal stability, low dielectric permittivity, and resistance to aggressive environments. Ceramic materials based on aluminum nitride (AlN), boron nitride (BN), and silicon nitride (Si_3N_4) represent a promising class of compounds characterized by a dense crystalline lattice, high melting points (>2000°C), and low dielectric losses.

The synthesis of such materials is achieved through methods such as hot pressing, reaction sintering, and chemical vapor deposition (CVD), enabling the production of dense, uniform, and highly stable ceramic composites. At the microstructural level, strong ionic and covalent bonds within the lattice impart unique combinations of mechanical strength and electrical insulation properties.

The objective of this work is to conduct a preliminary economic assessment of the use of nitride ceramics in the composition of radio-transparent coatings (radomes, protective shields, and antenna covers) for high-frequency (HF) technology. Based on a comparative analysis of published data on the synthesis costs and lifecycle performance of these materials, a "cost-efficiency" model was proposed, allowing consideration of not only initial manufacturing expenses but also anticipated longevity and reduced operational losses.

The results obtained indicate the significant potential of nitride ceramics for use in next-generation structures, particularly when taking into account strict requirements for mass, dimensions, and resistance to extreme thermal and electromagnetic loads. The economic evaluation performed provides grounds for recommending AlN and Si_3N_4 as key materials in defense and aerospace projects, provided that production costs are optimized.