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Fractal frontiers in microelectronic ceramic materials

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Abstract

The world's perennial need for energy and microelectronic miniaturization brings with it a broad set of technological and scientific challenges. Materials characterized by precise microstructural architectures based on fractal analysis and ranging in size down to nano scale represent an important avenue for finding novel solutions. Deep materials structure hierarchies of this type open new possibilities in capacity according to the Heywang model, especially when extended by a fractals approach and intergranular relationships supported and recognized by their fractal nature. These developments are opening new frontiers in microelectronics miniaturization. They build on early fractal applications that were used as tools in miniaturization research and also provided application perspectives for diverse energy technologies. In other words, fractals, as a crucial concept of modern theoretical-experimental physics and materials sciences, are tightly linked to higher integration processes and microelectronics miniaturization. They also hold potential for meeting the energy exploitation challenge. In this research context, for the first time we experimentally and theoretically investigated the electrostatic field between the grains within fractal nature aspects. It is essentially a theoretical experiment based on samples of experimental microstructures imaged with SEM, as previously published in a number of other papers. We now take the research a step further by consolidating the experimental samples with respect to the predicted distribution of grains and pores within the sample mass.

We make an original contribution by opening the frame of scale sizes with respect to the technical processes of consolidation. This lets us predict the constitutive elements of the

microstructures – approximately equidistant grains and pores. In this paper we define in a practical manner the final target elements for experimental consolidation of real samples. It is the main bridge between a designed microstructure and related characteristics – for example, fractal dimensions and final properties of next-generation fractal microelectronics.

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Keywords

Ceramic materials; Microelectronic miniaturization; Fractals; Electrostatic field; Energy technologies

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