

Hafnium Oxide as Efficient Material for a New Generation Dielectric

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In the early 2000-ies, world leaders in the field of computer engineering, such companies as IBM, Intel and Samsung Electronics announced the development of a new technology for the production of boards based on multilayer films “HfO₂-Al₂O₃” on a silicon pad using the method of atomic layer deposition (ALD) [1]. The board has a high dielectric constant value thus making it possible to produce smaller transistors with increased operational speed, to reduce leakage current and electric energy consumption. It has been known that hafnium oxide is used in the production of optical devices, resistors, electronic ceramics, neutron absorption compositions and catalysts. High purity of material is one of key conditions for its application. As source material, hafnium concentrate was used that was enriched to 10% in the form of K₂(ZrHf)F₆ salt – the product of fractional crystallization of zirconium and hafnium fluorides in the production of zirconium for nuclear applications. Another source material is a HFO2 commercial-grade hafnium oxide produced at Vilnogorsk Mining and Smelting Works. Key process stages are fusion with alkali at a temperature of 800°C, dissolution in nitric acid and extraction. The impurities content of resultant hafnium re-extract is 10-5% (mass). The prime objective of the process technology is the preservation of hafnium purity in its oxide production, which is attained by the application of materials and equipment items having a high corrosion resistance, such as stainless steel, crucibles made of high-purity silicon, reaction vessels made of zirconium and fluoroplastic. Centrifugal extractors [2] allow the key critical process of hafnium extraction purification to be sufficiently effective, resulting in obtaining the product of a required 99.99% purity. Physical properties of hafnium oxide are presented in sufficient detail in [3]. Hafnium oxide can be produced using various methods to be selected based on the requirements to product quality, process efficiency and cost considerations.

- [1] G. Resnik, Technology on the Verge; Metally Mira, *International Review* **12**(48), December 2002.
- [2] G.I. Kuznetsov, A.A. Pushkov, A.V. Kosogorov, *Centrek Type Centrifugal Extractors*, M. 2000, 216 p. (in Russian).
- [3] I.A. Shcheka, K.F. Karlysheva, *Chemistry of Hafnium*, Naukova Dumka, Kiev, 1973 (in Russian).