POROUS SILICON RESEARCH IN BELARUS

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Porous silicon (PS) is a special morphological form of silicon characterized by the presence of a highly developed porous network in the silicon crystal.

In 1956, Arthur Uhlir from the Bell Laboratory was the first to disclose PS formation during anodic electrochemical etching of silicon in hydrofluoric acid. In Belarus, research aimed on PS formation and application was initiated by the academician V.Labunov. The first PS samples were obtained and studied by the employees of the Microelectronics Department at Belarusian State University of Informatics and Radioelectronics (BSUIR) I.Baranov, V.Bondarenko [1].

In 1979, dielectric isolation technology was worked out on the basis of oxidized PS and introduced into pilot production of bipolar integrated circuits. This technology has an abbreviation of IPOS (Insulation by Porous Oxidized Silicon), and for many years, Belarusian electronic industry enterprise "Integral" has been using it to produce test specimens of new developed integrated circuits. In 1980, the use of IPOS technology made it possible to obtain the first in the former Soviet Union samples of bipolar 4K SRAM [2].

In 1980, V.Labunov, V.Bondarenko and L.Glinenko from BSUIR began study of the silicon epitaxial growth on PS [3]. They showed for the first time that there is a possibility to decrease considerably density of impurity-vacancy clusters, as well as to decrease thickness of transition layers in silicon layers grown epitaxially on PS, and defined theoretically requirements for the stable epitaxial growth of silicon nonporous layers on PS. These results heightened the interest in studying the possibility to use PS as a buffer layer for gathering heteroepitaxial layers. In 1988-1989, gallium arsenide epitaxial films on PS were obtained. In 1993, V.Bondarenko, A.Dorofeev, G.Troyanova and N.Vorozov from BSUIR, and V.Levchenko, V.Dikareva and L.Postnova from the Institute of Solid State and Semiconductors of the Belarusian Academy of Sciences, grew PbS heteroepitaxial film on a silicon substrate with the PS buffer layer and demonstrated photodiode structures [4, 5]. This research initiated similar works in Russia and abroad on the use of PS as a buffer layer for deposition of films of different semiconductor compounds and diamond films.

In 1982, V.Bondarenko and A.Dorofeev started research on diffusion of impurities in PS and effect of fast-diffusing impurities gettering by PS layers. In 1985, they developed PS based gettering technology that allowed to increase lifetime of carries and to improve characteristics of transistors of integrated circuits[6, 7].

In 1985-1989, V.Borisenko, V.Bondarenko and V.Raiko studied metal deposition in PS pores with the consequent heat treatment of the obtained material. In the result, technology of thick metal silicide layers formation in silicon wafers was worked out.

In 1985-1991, research aimed to create SOI-structures (Silicon on Insulator) on the basis of oxidized PS for "Integral" was performed. In 1991-1992, for the first time in the former Soviet Union, logic CMOS ICs with the record speed were obtained and studied [8].

In 1986, P.Jaguiro and V.Bondarenko from BSUIR revealed an effective electrochemiluminescence on PS electrodes. The similar result was only watched by foreign scientists in 1992. Investigations of luminescent and electrical properties of nanoporous silicon subjected to different treatments are represented in [9-11].

In 1986, V.Bondarenko started study of waveguiding properties of oxidized PS. In 1992, this

study resulted in creating integrated waveguides with losses less than 1 dB/cm intended for optical connections in silicon structures [12]. The similar results were obtained abroad three years later.

In 1995, research to incorporate rare earth elements into PS was initiated. In 1995, doping of PS by erbium from sol-gel films was carried out for the first time and in 1996, erbium was incorporated into PS with concentration of about 0.1-0.5 at % by electrochemical deposition from erbium salts solutions [13]. These studies are being carried out at BSUIR by V.Bondarenko, V.Petrovich, S.Volchek, L.Dolgyi and N.Vorozov in cooperation with N.Kazuchits from Belarusian State University, V.Filippov from the Institute of Physics and P.Pershukevich from the Institute of Atomic and Molecular Physics of Belarusian Academy of Sciences.

In 1995-1999, S.Lazarouk and P.Jaguiro developed a light-emitting diode based on PS and aluminium anode oxide [14]. The devices radiate light in the visual and IR bands, and up to now have the best reliability in the world.

Belarusian scientists have published more than 200 scientific articles and received 49 inventor certificates on the topic of PS. In the encyclopaedia "Porous Silicon Properties" published in 1999 in the UK by the EMIS Publishing House two units ("Microelectronic Application of Porous Silicon" and "Porous Silicon in Optoelectronics") are made by the BSUIR employees [15].

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