APPLICATION PROSPECTS OF THE LIME SAPPHIRE IN THE INDUSTRIES AND AN URGENCY OF ITS SUPERFICIAL PROCESSING

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ABSTRACT.Monocrystals of the lime sapphire, thanks to the properties, find wide application by manufacture of hi-tech products in the field of nano technologies. For manufacturing of the specified products it is necessary precision processing of a surface with reception nanometers a relief. Traditional processing represents the difficult technological scheme with finishing polishing in excited environments. The perspective method of quasiplastic processing allows to receive a high-quality surface at a stage of diamond grinding.
Keywords: lime sapphire, microelectronics, quasi-plastic grinding, base layers, roughness.

ПРАКТИЧЕСКИ ПРИЛОЖЕНИЯ НА ВАРОВИКОВ САПФИР В ПРОМИШЛЕНОСТТА И НЕОБХОДИМОСТ ОТ НЕГОВАТА ОБРАБОТКА

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РЕЗЮМЕ: Благодарение на своите качества, монокристалите на варовиковия сапфир намират широко приложение при производството на високотехнологични продукти в областта на нанотехнологиите. За производството на определени продукти е необходима прецизна обработка на повърхността. Традиционната обработка се извършва по трудна технологична схема. Перспективен метод за квази- пластична обработка дава възможност да се получат висококачествени повърхности.
Ключови думи: варовиков сапфир, микроелектроника, квази- пластмасово шлайфане, слоеве, грапавини.

Modern scientific and technological progress are inextricably linked with the development and the development of new materials and breakthrough technologies. The material became a key factor determining the success of many engineering solutions when creating complex electronics. Now is the scope of lime sapphire (the white synthetic sapphire) in different articles appliances, devices and appliances. The white synthetic sapphire is a corundum - a colorless transparent mineral, aluminium oxide Al_2O_3. Natural minerals serenity and constitute a precious jewelry stones. For technical purposes used synthetic corundum. According to research, basic physical properties of synthetic corundum are very close to natural. Currently the principal methods of cultivation surround those produced by monocrystal synthetic sapphire in Russia are: Czochralski, Kiropulusa (its method Musatova-GOI), Bridgmen, Vernel, and horizontal crystallization (SOC). For the production of crystals profiled lime method of Stepanov. Stepanov are grown mainly method ribbon to manufacture of various optical windows, because the tape is homogeneous quality material required for substrates. Qualitative synthetic sapphire single crystals grow crystals, but this method requires a more sophisticated equipment and highly qualified service personnel. Large single crystals lime is grown mainly according to the method Kyropoulos. The method is quite simple and well developed, but has a number of deficiencies that affect the quality of synthetic sapphire. Specialists from the Zelenograd proposed a number of designs to improve the growing method of synthetic sapphire. For example, of the proposed new design heater, this allows you to reduce the formation of bubbles and MOOG in the orderliness of lime. Design heater and the technological improvements patents of the Russian Federation. Heaters tested plants cultivation and showed good results which allowed raise output cylindrical workpieces from those produced by monocrystal for production of high-power LEDs and bring it to 40%. There are patents on methods and devices of lime. Single crystals of synthetic sapphire, produced a variety of methods have the same physical and chemical properties, but different technical specifications required for use in a science and technology. Table 1 shows the results of a comparative analysis of the technical characteristics of synthetic sapphire crystals grown various methods.

Table 1

Characteristics of synthetic sapphire monocrystals with various ways of growing

Performance	SOC	Vernel	Chohralsky	GOI (Musatova)	Stepanov
Optical homogeneity	high	medium	high	medium	medium
density defects	low	high	low	medium	high
speed crystallization	medium	low	low	medium	high
internal pressure	low	high	medium	medium	high
Configuration grown material	plates	bolls, half bolls	bolls	bolls	band, the profile
roasting	not required	required	required	required	required
Cost	medium	low	high	medium	low

Note: orientation of the optical axis – any specified

Using of synthetic sapphire in various industries due to its characteristics: high transparency; resistant to UV radiation; resistance to mechanical damage and high temperatures; high dielectric properties; especially lattice to grow Epitaxial layers on it; the highest strength; low coefficient of friction; ability to make sound very thin (tip blade scalpel); chemical and biological passivity.

Synthetic sapphire is produced on an industrial scale around the world and used effectively in every major industry [1]. The main product range from lime is given in table 2.

Table 2

The main product range from synthetic sapphire main technical requirements and applications

Production name	**Material quality criteria, optical uniformity (min)**	**Size (configuration)**	**Cleanliness of processing (End result)**	**Commodity market**
Watermark	1-4 high	Drives (up to 200 mm thickness) up to 15 mm	Polished	Optoelectronics, microelectronics, semiconductor equipment, chemical industry, special-purpose products
Lenses	1-4 high	Drives (up to 200 mm thickness) up to 15 mm	Polished	Optics, lighting, and precision engineering, metallurgy, special-purpose products
Glasses (Windows)	5-8 middle	Drives (up to 200 mm thickness) up to 15 mm	Polished	High-temperature optics, metallurgy, precise engineering, lighting equipment, special-purpose products
		Plates 200x95x25 300x200x20		Optical equipment (window bar code scanners), lighting equipment, chemical, hour industry, exact mechanical engineering, special-purpose products
Special purpose	1-8 middle	Drives (up to 200 mm thickness up to 15 mm,	Grinding, Polished	Military equipment, small series appliances and equipment (elements of research and technological equipment *), exact mechanical engineering
		Plate 200x95x25 300x200x20		
Structural products	5-8 middle	Drives (up to 200 mm thickness up to 15 mm,	Grinding, Polished	Military equipment, small series appliances and equipment (elements of research and technological equipment *), exact mechanical engineering
		plate 200x95x25 300x200x20		
Rods, tubes, strips, etc.	1-6 middle	Under the order	Grinding, Polished	The chemical industry

Note: reactors high pressure and high temperature furnaces CVD system, lasers, thermoelements covers, waveguides, fiber optics, vacuum equipment, evaporative cell injection for molecular beam epitaxy process, boats and crucibles for growing crystals, containers for melting especially pure substances, etc.

Semiconductors based lime sapphire operate in those conditions, in which the silicon-based semiconductors their order. Every year there are new scopes of lime sapphire in the manufacture of various electronic devices and appliances. Optoelectronics is one of the main consumers diameter substrates for the production of high-power super bright diodes (led) (HB LED) and solid-state lasers, blue, white, green light. Today in Europe as substrates for LEDs use two material: Sapphire, his production of cheap and technologically not difficult, and silicon carbide or carborundum composite galvanic coating. The brightness of the new LEDs twice exceeds analogues, available on the market, and quantum yield is 34.9%. When using this element as the backlight screen, for example, in mobile phones, with the same brightness required half the energy.

The main tendency that microelectronics reaches new indicators, this minimization sizes marked structures. Geometrical elements define the parameters and properties of devices, and reject sizes lead not only to changes in the technical characteristics, but also render. The steady improvement of microelectronic devices reduced the minimum size of the components to sub-micron values and the density of their packaging on a flat base increased by several orders of magnitude. The dimensions of the substrates are selected according to the degree of integration of integrated circuits (IC) their materials — in line with what is required for electrical, mechanical and thermal properties of substrates with [2].

It is obvious that the decrease of elements and the increase in density compositing has increased demands and to the quality of treatment and, of course, to her regimes. The quality of the surface layer of substrates with significantly influences the properties of the substrates and reflected on the circuits and devices created with using them. In these circumstances, when finishing materials on the inadmissibility of chips, cracks, mikrodefektov and dislocation in most of the material. The traditional way of processing solid fragile minerals (including crystals) is a mechanical polishing free and abrasive Blaster. After this processing is surface roughness of about 200 nm and disturbed subsurface ground layer. To achieve the necessary roughness (for example, diameter 0.2 nm) at manufacture high-power harvesting polished in hostile environments. In Figure 1. 1 see technological scheme of production lime sapphire plates.

The traditional method has a number of shortcomings, the major one: the problematic achieving stable duplicate processing settings, the forest of subsurface layer substrate (even after polishing) and the high percentage of damage in surface substrates [3].

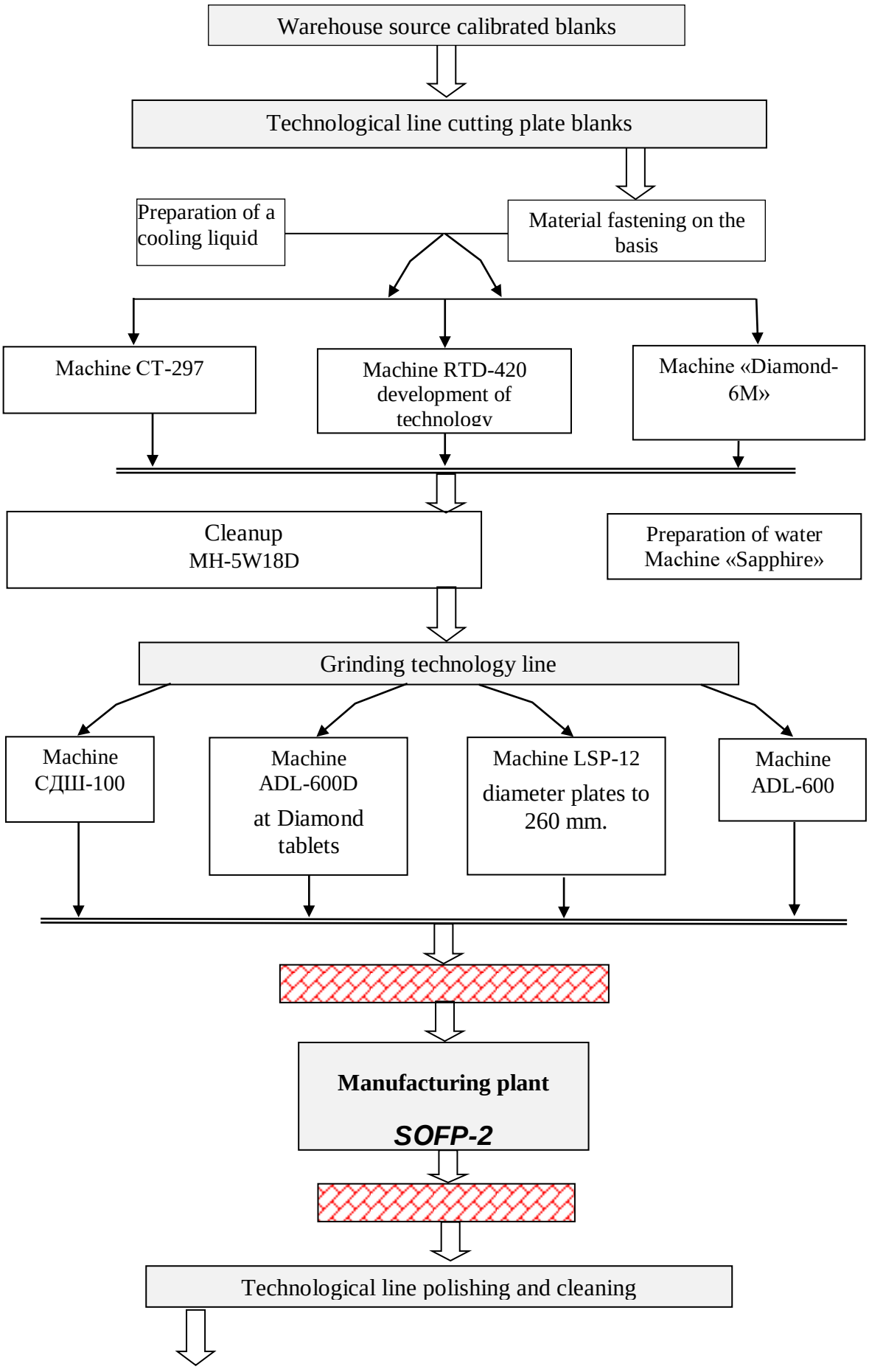
Modern machines for grinding free abrasive blaster have electronic starters and job pressure to eliminate defects are fragile, however, despite the introduction of the monitoring process, reduce the tedium of operations, the shortcomings of this method is not removed. Characteristic as a defect grinding free abrasive Blaster is education scratches caused by kinematics relative motion plates for polish circle, which is a great strength of grains of diamond. The troughs with alumina grains form scratches, but because of low productivity, also has no prospects in case processing sapphire. For solutions leading industries to finishing sapphire requires precise removal of surface soil mineral with getting nanometres a terrain surface and with minimal defects introduced the process of handling.

A promising way of obtaining quality particulate fragile crystalline materials surface nanometres a terrain is removing surface layer mode quasiplasticity [4].

Quasiplasticity solid materials technology is based on providing mechanical impact on surfaces material when grinding wheel of the proportion of μm/progress. The surface layer of brittle solid materials exhibit ductile properties and predominant mechanism becomes not fragile crashing, and quaziplasticity removing surface layer of material [5]. When data submissions contact interaction between wheel with treated surface creates periodic variable mechanical field, which happens to quaziplasticity removing surface layer with formation of nanometer surface roughness and with minimal defects (no more than 50 nm) made the process of handling. When quaziplasticity removing surface layer requires automation process with an unbroken machined surface nanometres a relief.

On the basis of theoretical studies were carried out experimental work at the choice of rational regimes quaziplasticity processing flat surfaces sapphire at the machine module AN15f4 [6]. As a result of the variation in size, speed, move the mortise filing desktop machine module path processing other options processing received positive results.

Apparatus- technological cheme production of polished Sapphire



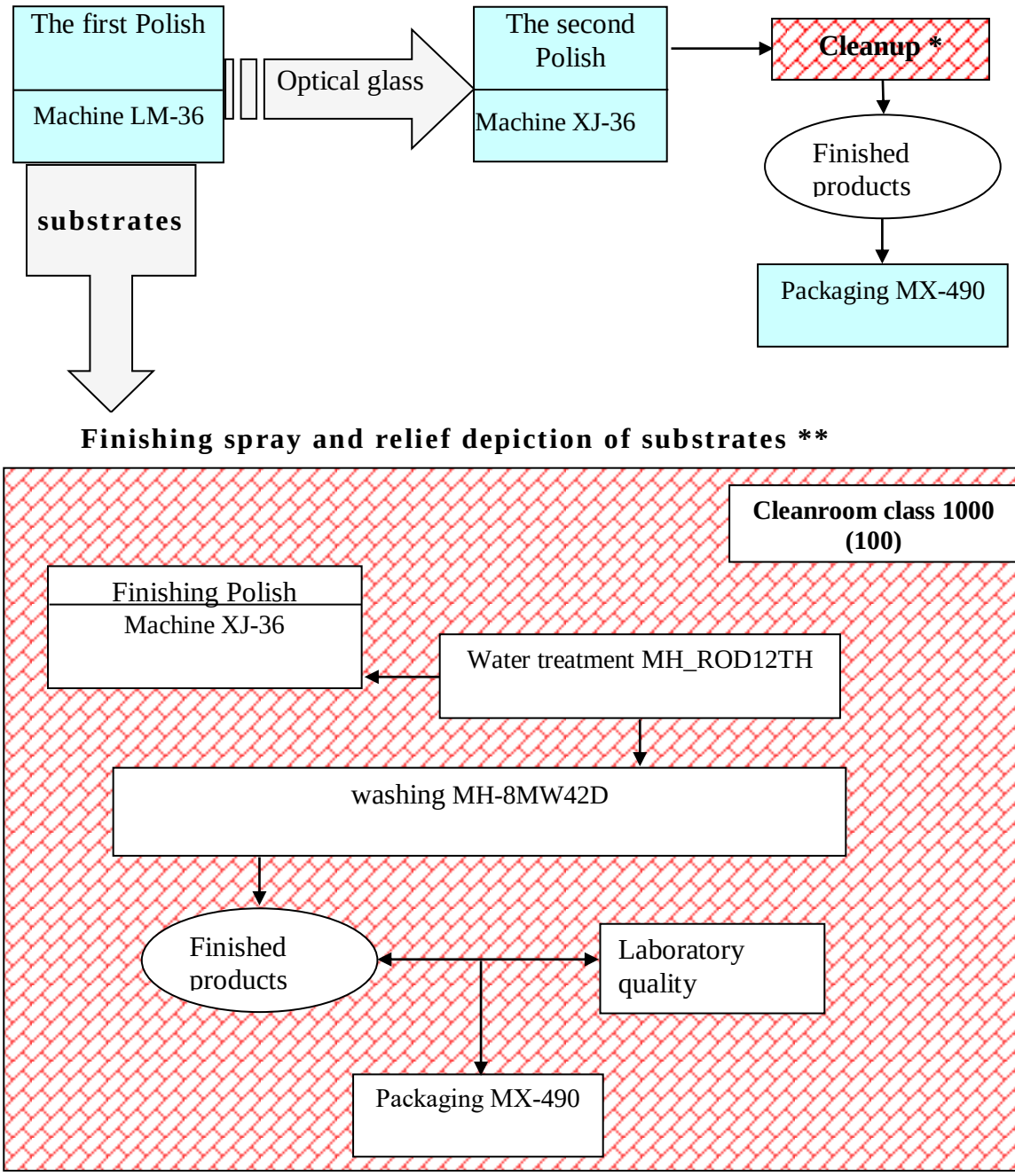


Fig. 1

Obtained from microrelief nm sapphire surface and subsurface ground layer of conserved land. In Figure 1. 2 results of research of the surface of the specimen and roughness measurement. Research has been conducted into Institute of common physics for interferometre white light "Zigo" newview 5000, resolution in plane object 0.45 μm in axesY-1 (a) (fig. 2).

The study showed that surface with no traces of brittle fracture received nanometer terrain. On the surface there is a gradient roughness with a minimum on the periphery. Surface roughness in the periphery of the average value of R_a = 8.08 nm. There are sites with roughness R_a = 1.946 nm.

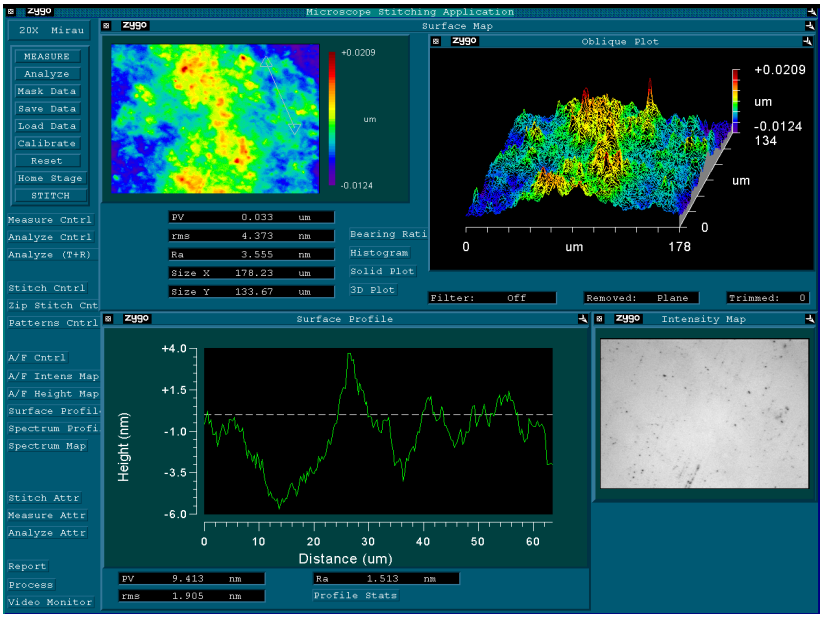


Fig. 2. The results of measurement roughness model No. 2

Conclusions through complex favourable chemical, electrical, mechanical, optical, thermal surface, and other unique properties lime sapphire has a wide range of application areas. How to handle quaziplastic mode allows you to get the processed surface roughness of 2-10 nm, making promising application for surface treatment of lime sapphire plates, because it reduces the time polishing in hostile environments. Identifying sound modes quaziplastic processing diameter and the possibility of technological diagnosis during processing makes it possible to automate the process of production of l lime sapphire substrates with surfaces of high quality. Demand for products of diameter annually growing at 10-15% demand substrates material for opto-and micro-electronics, microwave technology grows by 15-20%. Market products from lime sapphire is one of the most promising and rapidly developing.

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