Journal of Investigations on Engineering & Technology
Volume 3, Issue 1, 6-9, 2020

Usage of Obsidian (Igneous Energy) in Both Radiation Detection and Fixed-Target Machine in Discovery of Subatomic Particles

Oğuzhan DERVİŞAĞAOĞLU*[1]

[1] Ege University, Nuclear Sciences, Nuclear Sciences, 35030, Izmir

(Alınış / Received: 14.03.2020, Kabul / Accepted: 02.04.2020, Online Yayınlanma / Published Online: 30.06.2020)

Keywords
Obsidian
Volcanic
Amorphous
Radiation Detectors
Fixed-Target Machine

Abstract: Obsidian is amorphous material which contains SiO_2 compound and also is to be taken out from volcanic mountains. 75% of obsidian comprises quartz. Quartz is the required material to observe the piezoelectric effect. Obsidian originally comes from the mantle of the earth crust. When it contacts with oxygen in the air, it solidifies suddenly with no any opportunity that switches to crystallized state. Because of that reason, it becomes amorphous silica. If some chemicals such as fluorine or hydrogen with respect to semiconductors process is connected into silicon (a-si:H) that let to see photoconductivity property will be revealed. Radiation detectors have an ability of absorption. In this article, obsidian is debated on whether it can be useful for radiation detection as an absorber or not and furthermore, is evaluated if obsidian is focused on the fixed target machine as stationary target area related with the discovery of subatomic particles.

1.Introduction

Obsidian mostly contains quartz. Therefore, some acknowledgements should have given about quartz material. The chemical formula of it is SiO_2 Which is quite similar to obsidian. 46.5 % of quartz is Si and 53.3% of it is O. Degree of the hardness of quartz is 7 according to the Mohs Scale, specific gravity is 2.65, melting temperature of quartz is 1785^0C. Because of it has Fe_2O_3 and Al_2O_3 compounds that give an oppurtunity to see its applications in industrial areas such as optics, electronics and making of ornamental stone [1].

Ouartz can decrease the melting point of dross which comprises volcanic rock such as obsidian. Amorphous silicon with H is quite crucial for the development of solar cells and crystal of Si must be in high purity when it is applied in the making of solar energy sources. So, an experiment such as GDD(Glow Discharge Decomposition) in another saying is PECVD (Plasma Enhanced Chemical Vapor Decomposition) has been applied. The most efficient advantage of amorphous semiconductor crystals is to provide large films to squeeze into an amorphous state very easily [2]. Purification of obsidian should have been considered. The purification process is quite important for many areas such as electronics, ceramics, metallurgy and paint. Physical and chemical process on removal iron from quartz is necessary to provide pure quartz material. Due to this reason, the logic of purification process on obsidian should have been exploited and then, the removal of iron and other mineral grains let to go on the process of hydrogen or fluorine adding to make pure silicon which boosts its own photoconductivity. N or P semiconductor doping will be used depending on neutron and proton numbers in silicon of obsidian material. a-Si:H semiconductors is generally used in the making of solar cells. H is a parameter of photoconductivity is revealed. On the other hand, Fixed-Target Machine(FTM) has a tremendous effect on the discovery of subatomic particles which helps to evaluate the nature of a universe where all living beings as utterly minor parts have been surviving for billions of years. Obsidian can be a good candidate for being a target in Fixed- Target Machine detector to create subatomic particles such as hadrons.

**Corresponding Author: promedyum@hotmail.com ORCID: 0000-0003-3901-9238*

2. Optical Properties of Obsidian and Nuclear Solid-State Detectors

Research of black and brown obsidian has been done by Scientists [3] which is related to both optical properties and natural radioactivity. In this study, obsidian is defined as alumino silicate glass which contains iron impurities and some tiny particles. It is formed as felsic lava extruded from a volcano cools suddenly that does not allow the atoms to recombine themselves in the crystalline state [4]. As a result of this study, black obsidian has rapid absorption to assign to band gap then brown obsidian has. Under 400 nm spectrum of wave length black obsidian has rapid absorption. So, if obsidian material put in the process the removal of iron and other mineral grains and adding H, photoconductivity level will be increased. Pure silicon of obsidian can be useful as semiconductor detector in low wavelength and in high frequency (Photon energy).

Semiconductor detectors are responsible to operate through the promotion of electrons from the valence band to the solid conduction band as a result of incident particle scattering into solid. The absence of an electron in the valence band behaves like a positron (hole). Electron-hole pairs play a role of electron –ion pairs in gas detectors.In the presence of externally applied electric field electrons and holes seperate and collect at electrodes. Most the semiconductors are made from silicon. When ionization radiation sent through semiconductor materials such as Si or Ge, charge carrier can occur in the semiconductor material and supply voltage, the electric field comes out electron-hole pairs go vice verse direction and finally observe current and this current increased in photomultiplier [19]. Obsidian has become silicate if it's converted to pure Si and when some doping atoms are connected to itself with respect to neutron-proton numbers that can be a candidate as a detector for usage of radiation applications. There are three different way to evaluate of gamma rays nature to create electrons in active material which are; photoelectric effect, compton scattering and pair production. The electric charge was devised by collecting of incident gamma photons in semiconductor detectors. When the amorphous semiconductors are compared to single crystals, they have the tremendous advantage of complicated geometries, flexibility properties in compositional and efficient electronic control. The disadvantage about amorphous semiconductors is to carry less charge mobility with respect to disordered state. Obsidian as a natural glasses were emerged from earth crust, in meteorites. In a study, Tektite and obsidian have been acclaimed as crucial in the category of natural glasses [5].

Obsidian can be evaluated as an amorphous semiconductor which is being a nuclear detector. Amorphous detectors can be an efficient tool for room-temperature detection of radiation. Obsidian has an important ability to record nuclear fission product. These types of glasses are called as solid-state nuclear track detectors. Originally, the first application of SSND has been carried out by a scientist called Young in 1958. He discovered that lithium fluoride crystals have been irradiated with thermal neutrons which were held from uranium oxide films [6]. Detection of charged particles can not be confined with the discovery of solid-state nuclear track detectors. Charged particles are going through dielectric materials such as inorganic glasses and plastics. These particles have an impact to create continuous damage as submicroscopic trails which are called latent track in the path where they are passing on. The latent track can be observed under a transmission electron microscope for scientific studies which are related to nuclear radiation physics. There is a correlation between both electrical resistivities of materials and the ability of storage tracks. Different materials demonstrated different sensitivities for nuclear particles. Usage of SSND has been expanded into many majors such as nuclear physics, cosmology, biology, material science, radioactivity, etc. SSND can be described as amorphous silicate which is mentioned before in the previous chapters such as quartz, feldspar, mica and glasses(obsidian) were discovered again in 30 years ago [7]. Most of the natural substances such as minerals have been using as solid state detectors. However, these substances are utterly crucial for applied sciences and not only give an advantage in fewer electronics, present inexpensive budget but also they are useful and aidful which can be applied in many fields for new discoveries [8].

SSND has been a tremendous role of performing detection of fission fragments in the existence of light charged particles of gamma photons and furthermore, heavy charged nuclear reactions are necessary such as alpha particles. They have an advantage about the determination of measurement fission decay constant for heavy radinuclides[9]. Organic polymers are known to be sensitive trail detectors and some of them can produce latent tracks which are occupied by alpha particles, deuterons, etc. According to studies which are made effort as cosmic rays have demonstrated that trail detectors have well threshold damage density under with tracks are not produced [10]. The heavy nucleus is an important subject over nuclear detectors. Uranium breaks up through fission fragments by solidification of some glasses such as obsidian. If uranium comprise is known well, the age of solidification of material can be obtained as in geochronology applications. This is known as fission track dating which is used in the much more branches such as archeology and cosmology [11]. Plastic track detectors have been very useful prospection of uranium/ thorium. Radon and thoron sensitive detectors have been used in prediction of the jolt of ground called as earthquake [12].

Studies in cosmology have been carried out by measuring fluxes of cosmic rays and luna samples have been giving a product with respect to thermal histories on the moon[13]. Trail analysis of meteoritic materials in lunar demonstrated us to evaluate subjects of; erosion on the surface of lunar and mass loss caused by ablation, fluxes of cosmic ray particles were seen in different time periods. SSTD can make these studies possible in cosmology by gathering data about the thermal and radiation subject of meteorites [14]. Solid-state nuclear track detectors have been using the determination of natural radioactivity on some elements such as uranium, thorium, boron, lithium, polonium, and etc. An incident particle which comes from the sample which would be solid as rock can emit weak gamma photons of some radionuclides which are mentioned before[15]. Fleisher et. al, have [8] made a research on the kinematics of gases in the region of the earth crust. SSNTD can be used for the fining of magnetic-optics iron. Latent tracks can be a parameter to evaluate changing magnetic properties such as iron garnets. Studies of nuclear track detections which are related to magnetic iron garnets can furthermore, a guide for evaluation of latent tracks in crysital structure [16]. Other applications of SSNTD will be the subject which is the radiobiology of plutonium. SSNTD has had an ambition and has had responsible for the mapping of plutonium concentrations [17]. The disordered atomic structure has been exposed to in the usage of hard x- ray among 60-300 keV related with the study of diffraction has various advantages which are; upper resolution in target space, comparison between x-rays and neutron data. The study of amorphous silica has been carried out at 95keV and synchrotron beamline in HASYLAB [18]. When all chemical and physical removal of O_2 and Fe, Al in obsidian and doping H or F for increasing photoconductivity is done, obsidian can be used for radiation detection as amorphous silicon nuclear detectors.

3. Fixed-Target Machine Detectors (FTMD)

Cyclic accelerators might be divided into a fixed-target machine and colliding beam machines. Particles in the fixed-target machine are accelerated to the highest operation energy and the beam is extracted from machine and directed through a stationary target which can be solid or liquid. Large colliders such as tevatron and relativistic heavy ion collider (RHIC) are located in Brookhaven National Laboratory, USA. In RHIC machine is capable of accelerating of heavy ions to high energies. There are several stages before ions are injected into machines. Two counter –circulating beams controlled by two 4 km rings of superconducting magnets and are accelerated to an energy of 100GeV/ nucleon. Gold ions are accelerated to understand of matter with extreme energy densities such as quark gluon plasma [19].

In a matter, quarks are confined within hadrons which can be thought of as a bound state of both protons and neutrons. Aquark- gluon plasma is believed to have existed in the first few microseconds after the big bang and it can exist at the center of neutron stars. When a specific example has been given, two heavy nuclei collide at high energies and interact via of gluon field, gluon and quarks deconfine and a form plasma that can radiate photons and lepton pairs. When the plasma cools that hadrons are emitted. This experiment is still questioned about the situation on what conditions are obligated to make quark-gluon plasma [19]. Inelastic electron scattering has a role of quark determination and elastic electron scattering is responsible for the determination of proton's energy.

4. Results

Data about obsidian has been given. Obsidian should have undergone to both physical and chemical process. Physical process contains magnetic separation and chemical separation of iron can be elucidated by oxalic acid. The next step will be doping H or F into obsidian to increase photoconductivity. Atoms in semiconductors are crowded and some disorders were occupied. If light or electromagnetic beam collide into the surface of semiconductors will gain more conductivity. Amorphous obsidian with the chemical removal process of Fe and Al is more useful in the making of radiation detectors. Fig 1., [3] has demonstrated that obsidian material have been sent to the process of thermoluminescence(TL) which is necessary to understand of interaction between light and matter and black obsidian under 400nm can pass easily band gap in high photon energy.

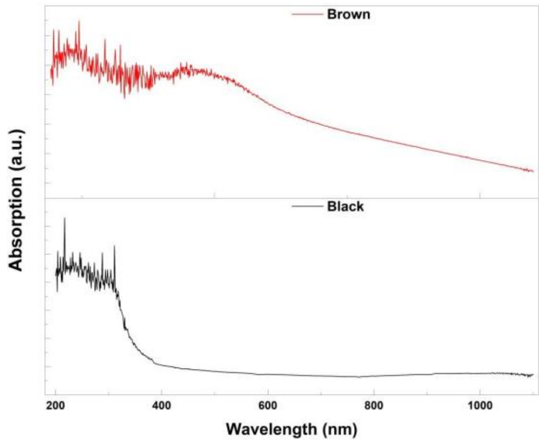

Fig.1. Wavelength of obsidians with respect to absorption

Furthermore, obsidian can be a stationary solid target as an absorber in fixed target machines. In Cern, proton-dark matter, electron-dark matter scattering experiments are carried out in the area with a range of 110 km. Charged particles should have been accelerated through a stationary target which is obsidian to understand what type of subatomic particle is existed after the experiment. Type of obsidian can be questioned and need to determine whether pure amorphous obsidian is used or not for the discovery of subatomic particles. When obsidian put into inelastic electron scattering, quarks can be observed. In CERN, electron-dark matter scattering, electron- hadron scattering and proton-dark matter scattering experiments have been carried out by scientists(Fig.2),[20]. Protons are collided through in magnetic force and hit the stationary target to observe neutrino which is related to dark matter. Obsidian can be a stationary target as an absorber to merge subatomic particles as baryons in the fermionic hadrons group.

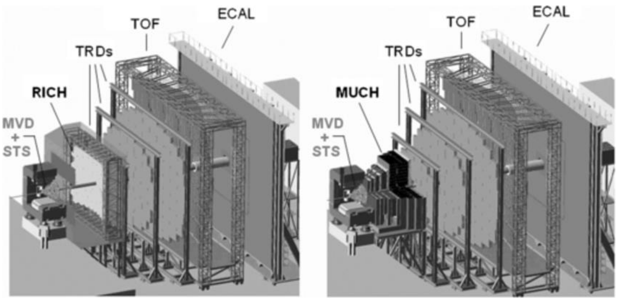

Fig.2. Fixed-Target machine for electron – hadrons experiments

In this paper, some of the study about quartz, chemical and physical removal of iron or other matters with oxalic acid is explained briefly. The main character which is obsidian with these processes can be pure and doping hydrogen or fluorine will provide photoconductivity for obsidian reaches more conducting properties. That is a crucial situation to make obsidian as an absorber in the detector that connected with photomultiplier tube in radiation detection. In high energy physics topics, accelerators such as in FTM, obsidian should be stationary targets to observe subatomic particles. The writer of this paper had drawn a scheme about obsidian is integrated into mechanism of the electric supplier in a straight line 6 years ago. This paper has been written as pure research.

References

[1] İpekoğlu, B.,; "Kuvars, Kuvarsit, Kuvars Kumu", İstanbul Maden İhracatçıları Birliği, Türkiye Endüstriyel Mineraller Envanteri, (1999), 102-106 pages

[2] Ruud E.I. Schropp, M.Zeman, "Amorphous and Microcrystalline Silicon Solar Cells: Modeling, Materials and Device Technology", Kluver Akademik Yayınevi, Boston (1998).

[3] Cengiz G.; Caglar I.; Bılır G.,Optical Properties and Natural Radioactivity Levels of Turkish Natural Obsidians,Vol 6,(2019), pages 138-141.

[4] Chataigner, C.; Işıklı, M.; Gratuze, B.; Çil, V.; Obsidian Sources in the Regions of Erzurum and Kars (North-East Turkey): New Data. Archaeometry **56**(3), (2014), 351-374 pages.

[5] Guo S. L.; Chan B. L.; Durrani S. A, Chapter 4 - Solid-State Nuclear Track Detectors, Handbook of Radioactivity Analysis (Third Edition) (2012), Pages 233-298 pages.

[6] Bhagwat A. M., Solid State Nuclear Track Detection: Theory and Applications, Indian Society for Radiation Physics, (1993), 1-34 pages.

[7] SiJk, E.C.H. and Barnes, R.S., Examination of fission fragment tracks with an electron microscope, Phil. Mag. 4, (1959) 970- 972 pages.

[8] Fleischer RL, Price PB, Walker RM: The Ion Explosion Spike Mechanism for Formation of Charged Particle Tracks in Solids. J Appl Phys, **36**:,(1965), 3645-3652 pages.

[9] Roberts JH, Gold R, Armani RJ: Spontaneous Fission decay Constant of 238U. Phys Rev, (1968),1482-1484 pages.

[10] Flerov GN, Perelygin VP, Otgonsuren O, On the origin of Tracks of Fission Fragments in Lead Glasses. At Energ, (1972), **33**:979- 984 pages.

[11] Durrani SA, Khan HA: Annealing of Fission Tracks in Tektites: Corrected Ages of Bediasites, Earth Plant Sci Lett, (1972), **9**:431- 445 pages.

[12] Campero AM, Fleischer RL, Likes RS: Changes in Subsurface Radon Concentration Associated with Earthquakes. Jr Geophysical res,(1980), **85**: 3053-3057 pages.

[13] Faul H, Wagner GA: Fission Track Dating, in Dating Techniques for the Archaeologist HN Michael and EK Ralph (eds), Cambridge: MIT Press, (1971), 152- 156 pages.

[14] Macdougall JM: Meteoritics,(1975), **10**:449 pages.

[15] Bodu R, Bouzigues H, Morin N, Pfiffelman JP: On the Existence of Amomalous Isotopic Abundances in Uranium from Gabon. Compt rend Paris, (1972), **275**:1731-1732 pages.

[16] Hansen P, Heitmann H, Smit PH: Nuclear Tracks in Iron Granet Films. Phys Rev, (1982), **B26**:3539 pages.

[17] Khan HA, Brandt R, Hirdes D, Tress G, Dersch G, Jamil K: Use of Mica Nuclear Filter in the development of a Background Free Radon Presonnel Dosimeter. Journal of Aerosol Science, (1983), **14**:232-237 pages.

[18] Poulsen H. P., Neuefeind J., Neumann H. B., Schneider J. R., Zeidler M. D., Amorphous silica studied by high energy X-ray diffraction, Journal of non- crystalline solids **188**(1,2), (1995), 63-74 pages.

[19] Martin, B.R.; Shaw G.; Particle Physics 3 rd Edition ISBN 978-0-470-03293-0.(cloth),ISBN 978-0-470-03294-7(Pbk.),(2008).

[20] Heuser J.M.; Ivanov V.V., The Compressed Baryonic Matter experiment at FAIR: physics of strangeness and charm, status of preparations, In Journal of Physics G Nuclear and Particle Phyiscs **35**(35),(2008).