Reconstruction the illumination pattern of the optical microscope to improve image fidelity obtained with the CR-39 detector

Cite as: AIP Conference Proceedings **2144**, 030006 (2019); https://doi.org/10.1063/1.5123076
Published Online: 23 August 2019

Hazim Gati Daway, Iman Tarik Al-Alawy, and Saja Faez Hassan

Reconstruction the Illumination Pattern of the Optical Microscope to Improve Image Fidelity Obtained with the CR-39 Detector

Hazim Gati Daway[1,a)], Iman Tarik Al-Alawy[2], and Saja Faez Hassan[3]

[1,2] Department of Physics (College of Science), Mustansiriyah University, Baghdad, Iraq
[3] Department of Physics (College of Education), Mustansiriyah University, Baghdad, Iraq
[a)] Corresponding author: hazimdo@uomstansiriyah.edu.iq

Abstract: In this study, the usual light source (Tungsten) used in the optical microscopy with intensity (924W/mm^2) was changed to another light source (LED) of intensity 1049W/mm^2). Eight pieces of the CR-39 (SSND) track detector with dimensions (1cm×1cm) and thickness (500μm) were irradiated with the Am-241 source, has radioactivity 12μci, for different irradiation times (30:30:270 sec) and direct contact with track detectors. After etched–and drying the track detectors, they were read under the optical microscope (Pro-Way) before and after the source of light changed. The number of tracks in using the intensity of the Fluorescence and LED cases of lighting through the optical microscope was calculated using software via digital camera (HDEC-50B) through the calculator screen. The results showed an increase in the visibility of the track boundary with a significantly higher number of visible tracks.

INTRODUCTION

The CR-39 detector is one of the best detectors of neutrons and charged particles such as protons, alpha particles, fission fragments, and heavy ions [1, 2]. In this research, the CR-39 solid-state detector was used with a thickness of 500 μm. Where they were cut into squares of equal dimensions 1 cm x 1 cm. Where they were cut into squares of equal dimensions 1 cm x 1 cm. Exposure time was 30, 60, 90, 120, 150, 180, 210, 240 and 270 second. Detectors are placed in direct contact with the source at a 90 ° angle. After four hours of chemical etching, the effects of the track were read using a digital camera (HDEC-50B) software connected to the optical microscope, whose tungsten source was changed by a light-emitting diode to obtain the tracks of the detector. The LED is considered good in use and cheap in terms of traditional cost. Light-emitting diode LED and other solid-state illumination sources are commercially available and can be very cost effective for custom building. Continuous LED techniques develop to increase brightness in the green and yellow parts of the visible spectrum. Because new markets have started to use in some microscopes. Large-scale microscopy is still one of the most sensitive and affordable options applicable to addressing a large number of biological questions. Combining the general use of the broad microscope with the availability of constant LED lighting sources will improve the quantitative nature of tungsten microscopy [3]. Before and after changing the light of the microscope by a LED source for the purpose of calculating the numbers of heavy alpha particles, the intensity of the path shall be at different times of irradiation. There are many previous studies in this field, exhibited by Ho et al. (2002) [4] where they used a variable light in the optical microscope system to evaluate the etching rate of the CR-39 and LR-115 detectors. While Vazquez Lopez et al. (2001) [5] examined the surface roughness and the function of different samples of the CR-39 detector. Also, Al-Jubouri et al. (2016) [6] studied the image analysis of the CR-39 and CN-85 detectors that were irradiated by thermal neutron. Besides, Hassan et al. (2018) studied the improvement of the illumination system in microscopic imaging of nuclear tracks using the light emitting diode [7].

The aim of this study is to solve the data through the Matlab program. Four tables were measured the quality without reference[8], such as the intermediate gradient (AG), measurement of improvement by Entropy (EMEE), and

The 7th International Conference on Applied Science and Technology (ICAST 2019)
AIP Conf. Proc. 2144, 030006-1–030006-5; https://doi.org/10.1063/1.5123076
Published by AIP Publishing. 978-0-7354-1889-9/$30.00

image quality assessment without reference based on wavelet conversion (NIQWT calculation recommended) to calculate the correlation coefficient (CC) on the two Tungsten (T) and LED (L) photoreceptors to compare the number of Alpha particles' nuclear tracks facing the two cases[9].

MATERIALS AND METHOD

Effect of Radiation on Polymers

The effect of radiation on polymers can either lead to degradation, which specifically leads to the breakdown of chemical bonds between the atoms in the main polymer chains, leading to the loss of solid polymer or structural strength and low molecular weight or leads to the overlap of molecules in polymers that are It is defined as an interaction that can bind polymer chains with cross-links [10]. This can lead to complex overlapping structures that increase polymer strength, rigidity and molecular weight. Some physical changes in the polymers caused by radiation may lead to discoloration or absorption change or result in overlapping productivity [11].

Ionization Radiation

Ionizing radiation is capable of striking electrons outside their orbits around atoms, which destabilizes the electron/proton stability and gives the atom a positive charge. Molecules and atoms are electrically charged ions. Ionizing radiation includes radiation that comes from natural and man-made radioactive materials. There are several types of ionizing radiation: alpha radiation, beta radiation, photon radiation (gamma ray, x-ray) and neutron radiation. These were collectively called ionizing radiation because of their ability to strip one or more electrons away from atoms in any material passing [12,13].

Thermal Neutron Scource

Neutron sources vary in intensity and in the energy of neutrons emitted. They can be classified into three groups of nuclear fission reactors, radioisotopes, and particle accelerators. It is clear that nuclear reactors are not portable and unsuitable for good nuclear logging sources. Radioisotopes are the most commonly used neutron source in well logging applications. Relatively limited particle accelerators (though growing) experienced good logging experience. Neutron sources (n, α) have a counterpart of α-radioisotopes with a low mass nucleus as a target. Compared to other isotopes, Beryllium ${}^{9}Be_{4}$is the most important target because it contains the highest productivity of neutrons. The long half-life (about 433 years) for ${}^{241}Am - {}^{9}Be$ has approximately a constant level of neutron flux from the source over the lifetime of the equipment (about 20 years). Active neutrons are formed after the interaction between the alpha particles and the nucleus of the target material As follows [14, 15, 16]:

$$ {}^{4}\mathrm{He}_{2} + {}^{9}\mathrm{Be}_{4} \rightarrow {}^{12}\mathrm{C}_{6} + \mathrm{n} + \mathrm{E} \quad (1) $$

Where the emission of alpha particles from Americium ^{241}Am, affects the target of ${}^{9}Be_{4}$ and produces a neutron on a wide range of energies with an average energy of about 4.2 MeV and a maximum of 10 MeV.

Characteristic of Alpha pocess in polymer

The etching cavities grow along the alpha particle tracks in the CR-39 detectors. The etched track is implanted in a conical-like structure. The track walls bend because the track etching rate increases with the low particle range. When drilling reaches the end of the particle range, the track is said to be "engraved". When all additional expansions of the route are continuing as a result of the large inscription, the track is said to be "over-etching". The continued over-etching extends the etching but gradually destroys the conical structure [17].

Light emitting diode

The basic principle of operation behind a light emitting diode LED is that it stimulates the behavior by negative carriers (n-type) and some by (p-type). When the charged carriers of different types are reassembled, the released energy may emit light [18]. LED lamps are the newest and latest addition to the list of energy-saving lighting sources. LED lights emit visible light in a very narrow spectral band, which can produce white light. This is achieved either by using a red-blue-green array or a blue phosphorescent LED lamp in addition to its light decay, which is less than 10,000 hours of testing. Although it is still in its infancy, the LED lighting techniques are good and give hope for the future [19].

RESULTS AND DISCUSSION

The first step in this research was to replace the tungsten light source used in the light microscope with the LED lamp. The relationship of the output analysis between the number of tracks and light levels measured by the Lux scale was studied before and after changing the light system in the optical microscope. In the second step, the number of for different irradiation times of the CR-39 detector was compared using Am-241. The relationship between the irradiation time and the number of tracks can be seen in Figs I and II. The behavior of this relationship is a linear behavior that reflects an increase in the number of tracks with increasing irradiation time at different densities of light, as shown in Table (I). In the third step, the MATLAB program was designed to identify image quality with four No-reference scales such as the average Gradient (AG), the measurement of Enhancement by Entropy (EMEE), and the No-Reference Image Quality Assessment Based on Wavelet Transform (NIQWT) were calculated to be recommended. A good correlation coefficient was obtained for these scales, as shown in Table (II). The best correlation coefficient was 0.6431 for the NIQWT scale. The statistical results show that photography was much better when using a LED light instead of using tungsten light in an optical microscope. Therefore, these processes have increased the number of nuclear tracks detected, as well as image clarity.

TABLE I: Number of Nuclear Tracks Before and After the Change of Tungsten Light with LED Light at Different Light Intensity and Irradiation Time (30:30:270).

Detector	Irradiation Time (sec)	Intensity of Tungsten Light (Lux)	Number of Nuclear Tracks (before)	Intensity of LED Light (Lux)	Number of Nuclear Tracks (after)
CR-39	30	16	33	139	446
CR-39	60	46	42	233	338
CR-39	90	63	52	358	557
CR-39	120	81	117	477	658
CR-39	150	92	145	919	736
CR-39	180	108	209	1102	2002
CR-39	210	119	127	1241	2112
CR-39	240	190	111	1267	2045
CR-39	270	240	77	1278	277

TABLE II: Correlation Coefficients for (AED, EMEE, NIQW) Scales Using Tungsten and LED Sources.

Images	Correlation Coefficient (NT, AED)	Correlation Coefficient (NT, EMEE)	Correlation Coefficient (NT, NIQE)
Group T	0.5377	0.3621	0.4851
Group L	0.6196	0.4649	0.6431

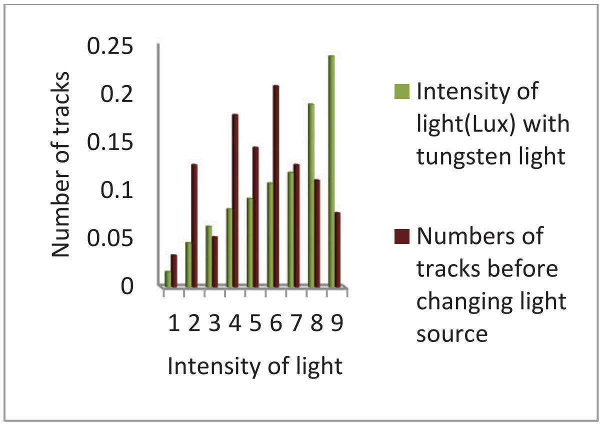

FIGURE I: The relation between maximum number of tracks and irradiation time with Tungsten light within optical microscope.

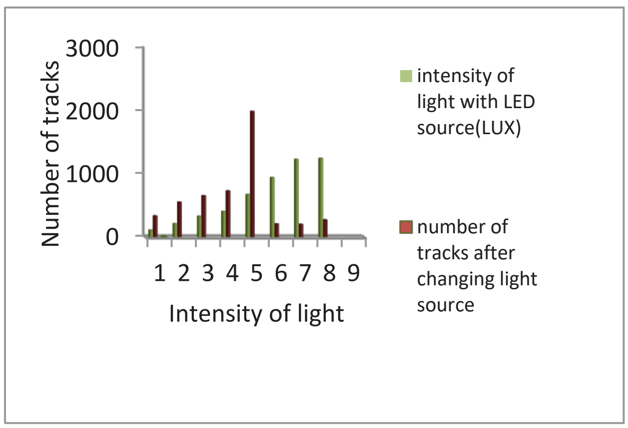

FIGURE II: The relationship between the maximum number of tracks and irradiation time with the LED light in the optical microscope.

CONCLUSIONS

This study exploded the possibility of changing the tungsten light used in the optical microscope by the light emitting diode source to increase the discovered number of tracks of alpha particles and increase the image clarity. The track has been irradiated by thermal neutron with different times to increase accuracy of the count and reduce the rate of error. The number of nuclear tracks before and after the tungsten light change was examined using a LED lamp when the intensity of the light and the irradiation time varied. It was found that the number of tracks ranged from 33 to 209 when using tungsten light and from 277 to 2112 when using the LED light. From these results we conclude that when using LED light instead of tungsten light, the number of tracks increased and the calculation of number of tracks process was corrected by 88% to 90% than the previous, due to image clarity. Finally, comparing with image processing using four no-reference scales, we conclude that LED light increases the number of nuclear tracks. In these processes, they increased the clarity and numbering of the nuclear tracks detected as correlation coefficients using Matlab between the T group with a value of 0.3621 and the group L having a value of 0.4649 in four no-reference scales. The results indicate that the correlation coefficient was high because it corresponds to the source of the light emitting diode used rather of the tungsten light in the nuclear tracks of the alpha particles on the irradiated CR-39 detectors with the Am-241 thermal neutron source increasing the clarity and thus the accuracy of the number of nuclear tracks of the detected alpha particles.

ACKNOWLEDGMENTS

The authors wish to thank the nuclear laboratories for postgraduate studies in the college of science and college of education at Mustansiriyah University, to provide administrative facilities in the implementation of this study under the environmental protection program from radiation. Also the authors of the present work would like to thank the college of science, college of education and their physics departments at Mustansiriyah University for their support.

REFERENCES

1. Barbui M., Fabris D., Moretto S., Nebbia G., Nemeth, P., Palfalvi, J., Pesente, S., Prete, G., Sajo-Bohus, L. and Viesti, G. "Nuclear Tracks in PADC Induced by Neutron, Heavy Ion and Energetic Fragments Formed in the Reaction 54Cr + 208Pb at 320 MeV". *Radiation Measurements*, 44, 857-860, 2009.
2. Saad, A.F., Hamed, N.A. and Abdalla, Y.K. "Identification of Spontaneous Fission Fragments by Using Thermally Annealed PADC Films". *Turkish Journal of Physics*, 37, 356-362, 2013.
3. Firas Mubaid , Daniel Kaufman , Tse‑Luen Wee, " Fluorescence microscope light source stability",Journal of Histochemistry and Cell Biology,14 Februery 2019. https://doi.org/10.1007/s00418-019-01776-6
4. Ho, J. P. Y. , Yip, Koo, Nikezic," Measurement of bulk etch rate of LR-115 detector with AFM", Radiation Measurement, 35, 571-573, 2002.
5. Vazquez-Lopez, C., Fragoso, R ., Golzarri, "The Atomic force microscopic as a fine tool for nuclear track studies", Radiation Measurement, 34,189-191, 2001.
6. Al-Jobouri H. A., Najam L. H. ,Rajab M. Y. , "Image Analysis of CR-39 and CN-85 Detector Irradiation by Theremal Neutron", International Journal of Recent Research Issue 1 وMarch 2016.
7. Hassan S.F. , Daway H. G., Al-Alaway I. T., " Improving an Illumination System in the Microscopic Imaging of Nuclear Tracks Using Light Emitting Diode", Indian Journal of Public Health Research & Development, V. 9, NO. 12,P. 1282-1287, December 2018.
8. NABEEL M. MIRZA, HANA H. KAREEM, Hazim.G. daway ," Low lightness enhancement using nonlinear filter based on power function", Journal of Theoretical and Applied Information Technology, Vol.96. No 1, P. 61-70, 2019.
9. Abd- Al ameer Z. S. , Daway H. G. , Kareem H. H. , " Enhancement underwater image using color restoration based on Integrated color model with Rayleigh distribution", Journal of Engireering and Applied Sciences, 14(2),P641-647,2019.
10. Billmer, F.W. "Text Book of Polymer Science". John Wiley and Sons. Inc. U.S.A., 1965.
11. Al-Niaemi, S.H. "Effect of electromagnetic radiation on the properties of nuclear track detector CR-39 and building of electrochemical etching system". Ph. D., Thesis, University of Mosul, Iraq, 1998.
12. "Introduction to Radiation", Canadian Nuclear Safety Commission (CNSC), p 7, 2012.
13. http://www.windows2universe.org/physical_science/physics/atom_particle/ particle_radiation.html.
14. Peeples, Cody Ryan, "Alternatives to the americium-beryllium neutron source for the compensated neutron porosity log raleigh", North Carolina University, M sc. thesis, 2007.
15. Kakavand, T., Haji-Shafeieha, M. AND Ghafourian, H., "STUDY of neutron yield for the 241Am-9Be source", Iranian Journal of Science and Technology, Transaction 33, p. 277 -280, 2009.
16. Taner Uckan, José March-Leuba, Danny Powell, James D. White and Joseph Glaser, "241AmBe sealed neutron source assessment studies for the fissile mass flow monitor", OAK RIDGE National Laboratory, 2003.
17. Durrani S. A., Bull R. K., "Solid state nuclear track detection: principle and application", University of California Press, Berkeley, 1975.
18. Duco Schreuder. "Outdoor Lighting: Physics, Vision, and Perception", Springer -Verlag, 2008.
19. "SLL Lighting Handbook" (published by the Society of Light and Lighting, CIBSE, 2009. http://ezzatbaroudi .files. word press. Com /2011 /02/ handbook. Pdf