Visible Blue-white Scintillation by Energetic Charged Particle Emission from Ni Film Cathode in Light Water Electrolysis at Room Temperature

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The method employed in the present work might be the simplest one ever known to realize the low energy nuclear reaction. Electrolysis is carried out for the Li_2SO_4/H_2O solution of 0.1 mol/L in a small plastic cell under DC condition at room temperature. The inner bottom of the test cell is a 5 μm thick Ni film serving as the cathode. The cell consists of a vertical plastic cylinder with inner volume capacity of ~8 ml, a plastic stopper holding a ϕ0.5 mm Pt wire anode, the Ni cathode, a scintillator composite and a transparent plastic plate in the lower portion. The cell is the same that used in the prior work [1], except that the scintillator composite and the transparent plastic plate, respectively replace the track detector CR-39 and the base block in the lower portion. The ZnS(Ag) is used as the scintillator, which is deposited on a polyester sheet to form the scintillator composite. The scintillation appearing in the ZnS(Ag) is observed by the naked eye without any electronics.

The key point of the method is in the lower portion of the test cell. To construct the lower portion, an optical grease is coated on the front surface of the 5mm thick transparent plastic plate, followed by mounting the scintillator composite on the optical grease. Then, the rear surface of the Ni film cathode is set in close contact with the front surface of the scintillator composite. The scintillation is observed from the rear side of the transparent plastic plate. The distance between the plate and the eye of the observer is ~12 cm. According to the result of a computer simulation, when an alpha particle is produced at the front surface of the 5 μm thick Ni film, ~3 MeV is the lowest energy of the alpha particle to penetrate through the Ni film and to reach the scintillator. The short penetration distance suggests that the use of thin Ni film is a key factor for detecting the alpha particle.

The single run of the electrolysis consists of the former run and the latter run. Total 6 runs are carried out. Pure water is added after the former run to fill up the test cell. The DC changes from 3 to 160 mA in stepwise every 24 h for 7d in the former run [1]. Similarly, the DC changes from 5 to 160mA in stepwise every 24 h for 6 d in the latter run. The time interval between the end of the former run and the beginning of the latter run is ~10 min. Thus, the electrolysis of the single run continues totally 13 d.

The observation of the scintillation is carried out in a dark room at arbitrary time during the electrolysis. The minimum unit of the continuous observation time is 10 min. The observation of 6×10 min is typically conducted twice in 24 h under each fixed DC value. The total time of 120 min in 24 h in a fixed DC value is equivalent to ~8 % of the electrolysis time. The color of the scintillation observed by the naked eye looks to be white mixed with a little blue. The scintillation appears in an extremely short moment and in different strength between the scintillations. The time interval between the flashes of the scintillation is found to vary exceedingly.

Average count of the flash per hour is defined as the flash rate. The flash rate increases with the DC value in both the former and latter runs. The rate in the latter run is larger than that in the former run at any DC value. These characteristic might be explained by increasing in the density of the proton absorbed in the Ni cathode by the electrolysis. The considerably high flash rate is found in the electrolysis experiment. Total 15 flashes are counted in the total observation time of 1 030 min under the 160 mA in the later run. These values give the largest flash rate of 0.9/h. Contrary, two flashes of unknown origin are observed in the control experiment in the total 900 min and these values give the flash rate of 0.1/h. The result reveals that the electrolysis markedly increases the flash rate. The scintillation could be attributed to the energetic charged particles produced by the possible low energy nuclear reaction in the Ni film cathode during the light water electrolysis.

[1] H. Yamada, K. Mita, H. Aizawa and Y. Shida, "Impressive Increase in Number of Etch Pit occasionally Produced on CR-39 in Light and Heavy Water Electrolysis Using Ni Film Cathode," Proceedings of the 14th Meeting of Japan CF Research Society, pp. 101-112, 2013.