SOLAR CONTROL ON IRRADIATED Ta_2O_5 THIN FILM

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OUTLINE

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BACKGROUND

- ✓ Ta_2O_5 films have been used in industrial applications related to thin-film capacitors, optical waveguides, and antireflection coatings on solar cells.

- ✓ Ta_2O_5 films are used for several application areas as highly refractive material and show different optical properties depending on the deposition methods.

OBJECTIVE

✓**This paper presents some data on solar control in terms of shading coefficient and its post irradiation behavior to obtain a complete study about the stability of generated radiation defects.**

✓**The changes on shading coefficient of irradiated Ta_2O_5 film on Corning 2947 are based on the absorbed dose in this study.**

✓**The radiation damages with Co-60 radioisotope and Sr-90 radioisotope lead to variations in optical properties of Ta_2O_5 films.**

✓**The mechanisim of optical transition is investigated in order to define the changes of optical band gap due to the interaction of radiation with the electron in the valance band of Ta_2O_5 film.**

EXPERIMENTS AND METHODS
a) Material Properties

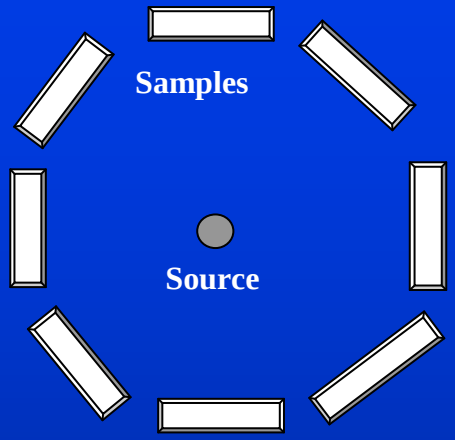
- **Substrate :** Corning 2947 microscope slide substrate
- The thickness of **Ta_2O_5 film** is about 150 nm.
- XRF Analysis of transition elements at Ta_2O_5 film on Corning 2947 is given in Table-1.

Table-1: XRF Analysis of transition elements.

Elements	%	+/-
Ta	0,13	0,02
Re	0,03	0,00
Zr	0,01	0,00

b) Irradiation Process

Co-60 Radioisotope

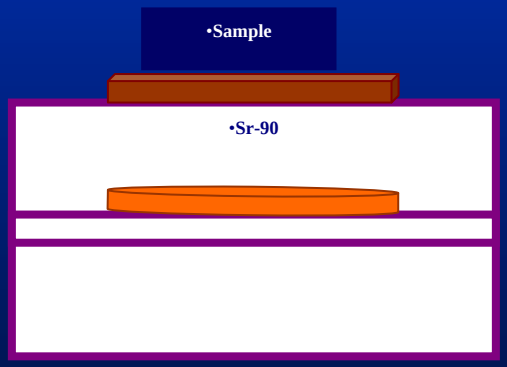


The setlement of samples

Co-60, E_γ , 1.17 and 1.33 MeV	
Activity	7.5 Ci
Half Life	5.26 years

The properties of radioisotopes

Sr-90 Radioisotope



Sr-90, E_β , 0.546 MeV, %100	
Activity	3.58 mCi
Half Life	28.1 years

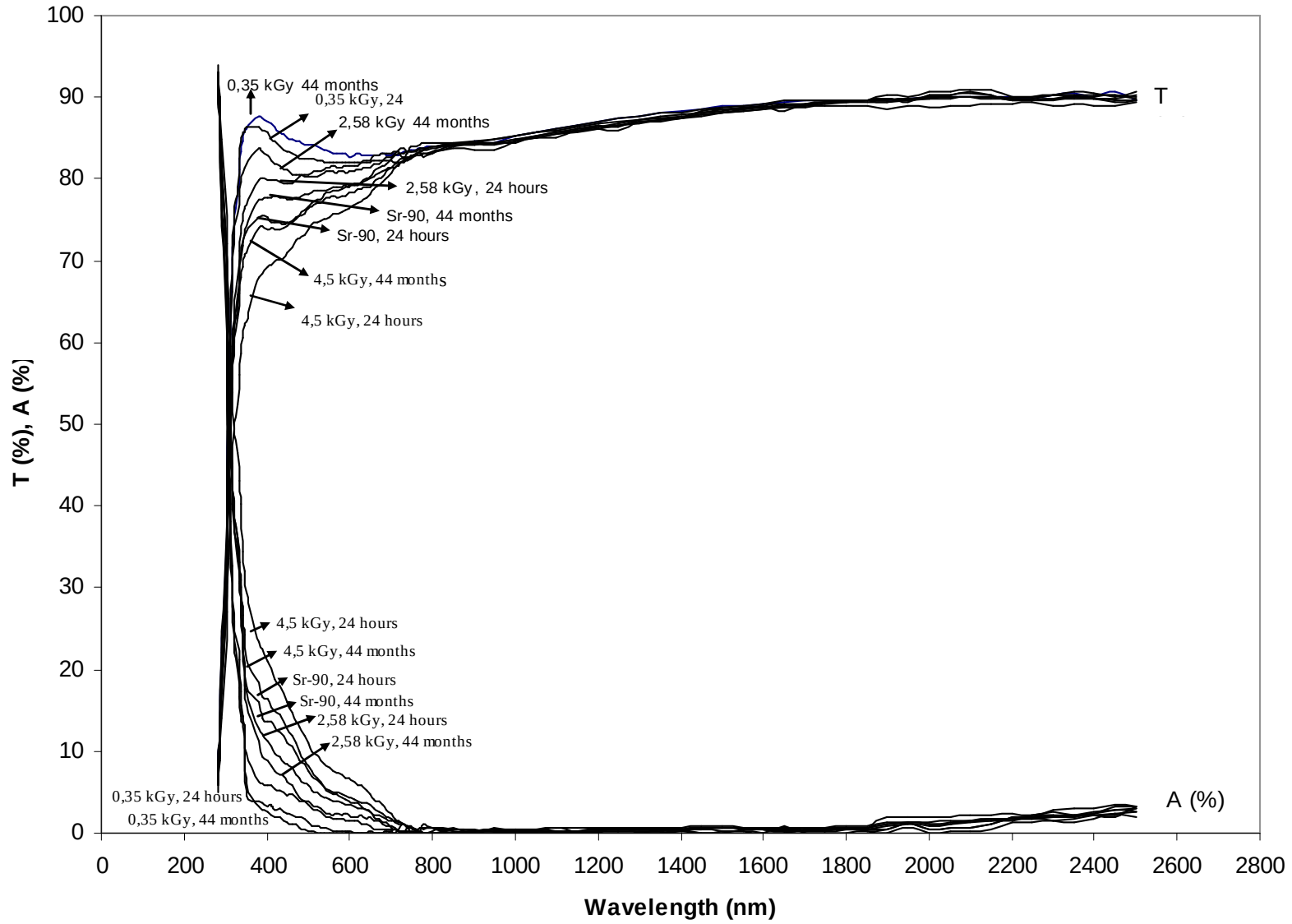
Irradiation was done at room temperature.

c) Details on Sol-Gel Process

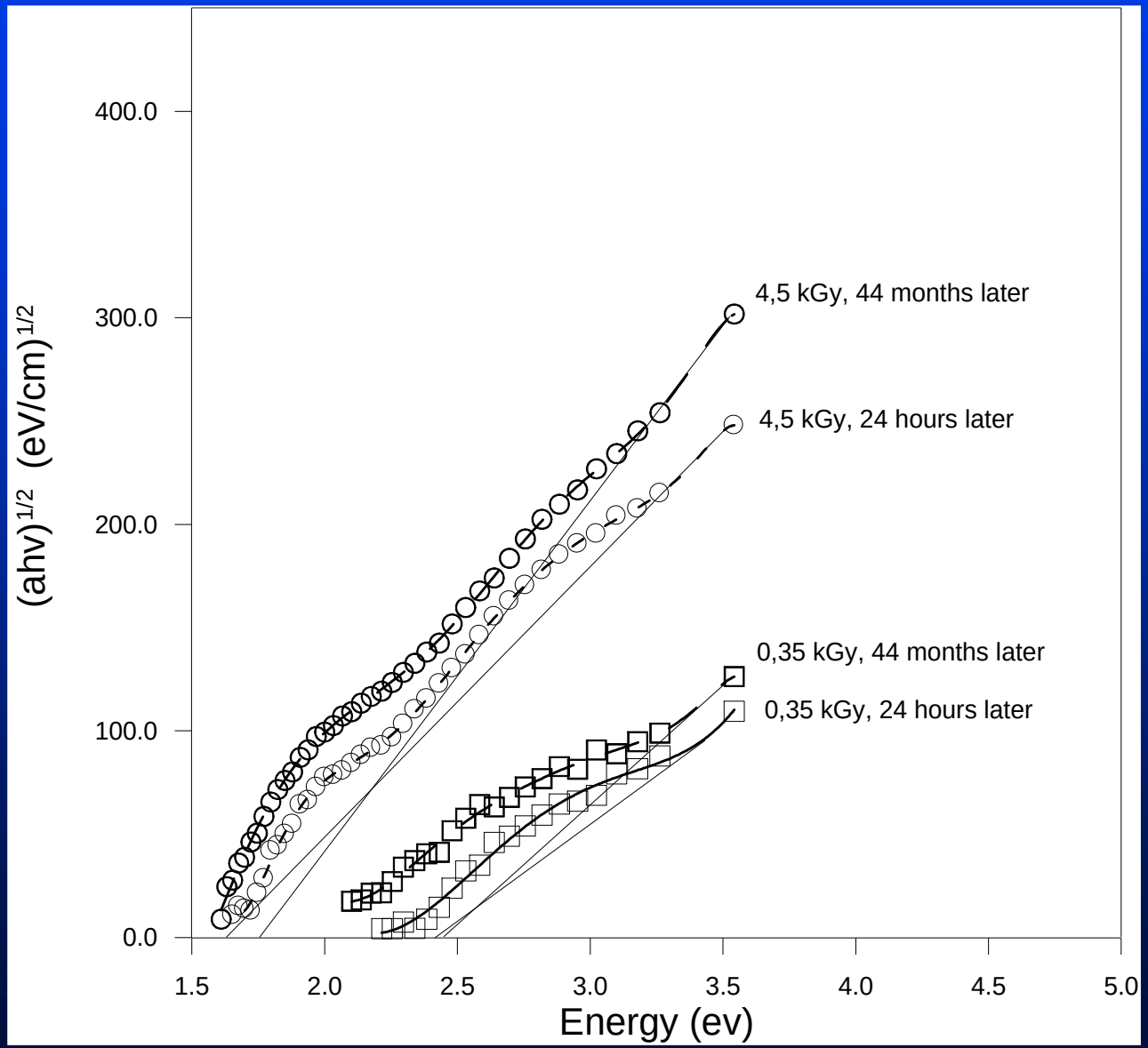
- Ta_2O_5 films were deposited by a spin-coating process.
- Tantalum oxide coating solutions were prepared by hydrolysis of tantalum ethoxide in absolute ethanol.
- The tantalum ethoxide was dissolved in ethanol and the molar ratio was 0.25.
- After the solution had been stirred for 30 min, it was diluted with ethanol and a small amount of water mixture.
- The mixed solution was catalyzed with glacial acetic acid and stirred for 18 h.
- The obtained solution was transparent. The spin coating speed was set at 2000 rpm.

RESULTS AND DISCUSSIONS

- The transmittance and reflectance at the range between **280 - 2500 nm** was measured using a spectrophotometer. The results were given in **Fig.1**.



- E_g for allowed indirect transition was determined by extrapolating the linear part of $(\alpha E)1/2$ vs. E plot, shown in **Fig.2**, to $\alpha=0$ (E is the energy of light in eV).



- When the absorbed dose of the samples increased, a characteristic optical density band occurred at ~ 630 nm in **Fig.3**.

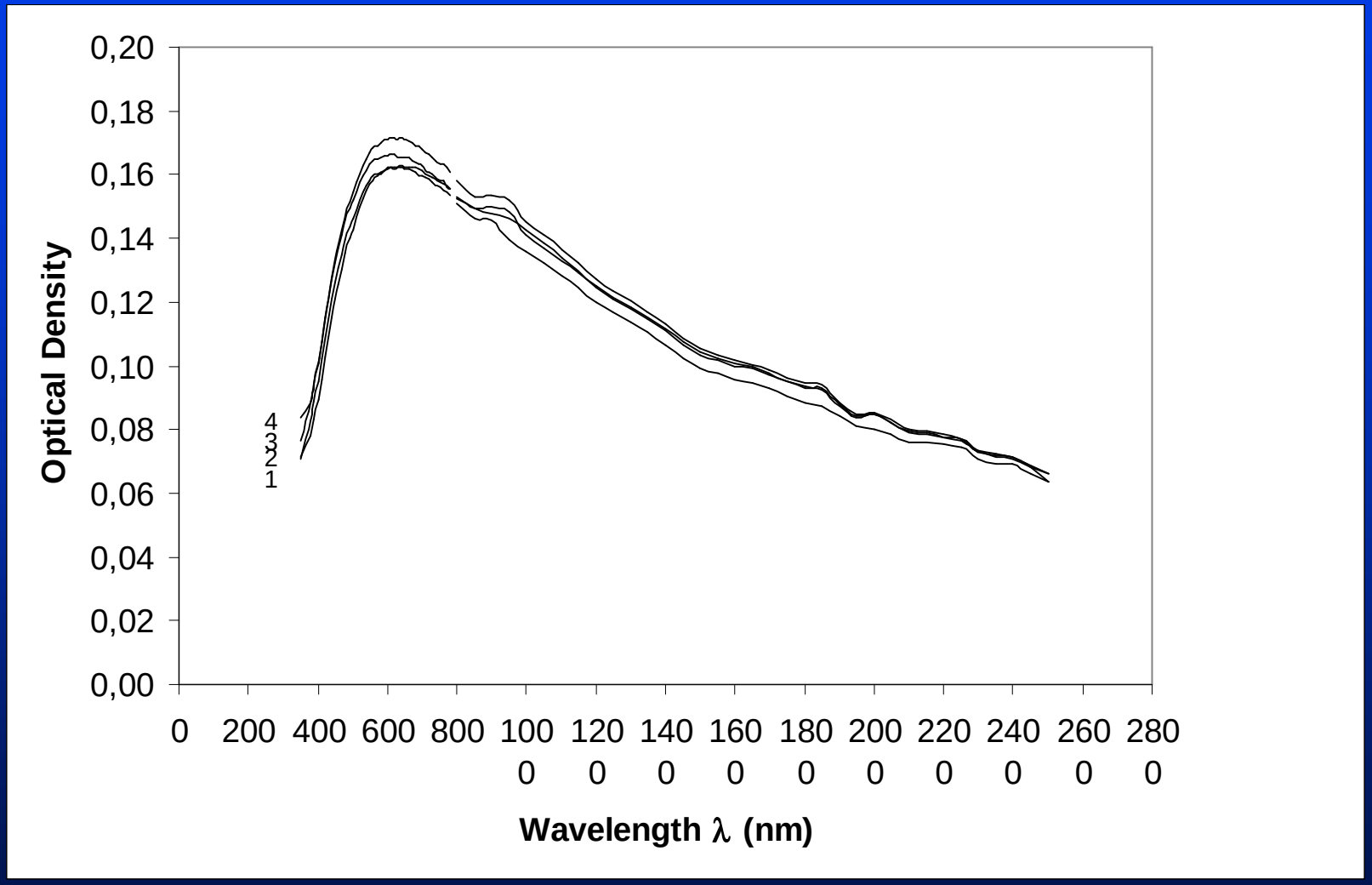
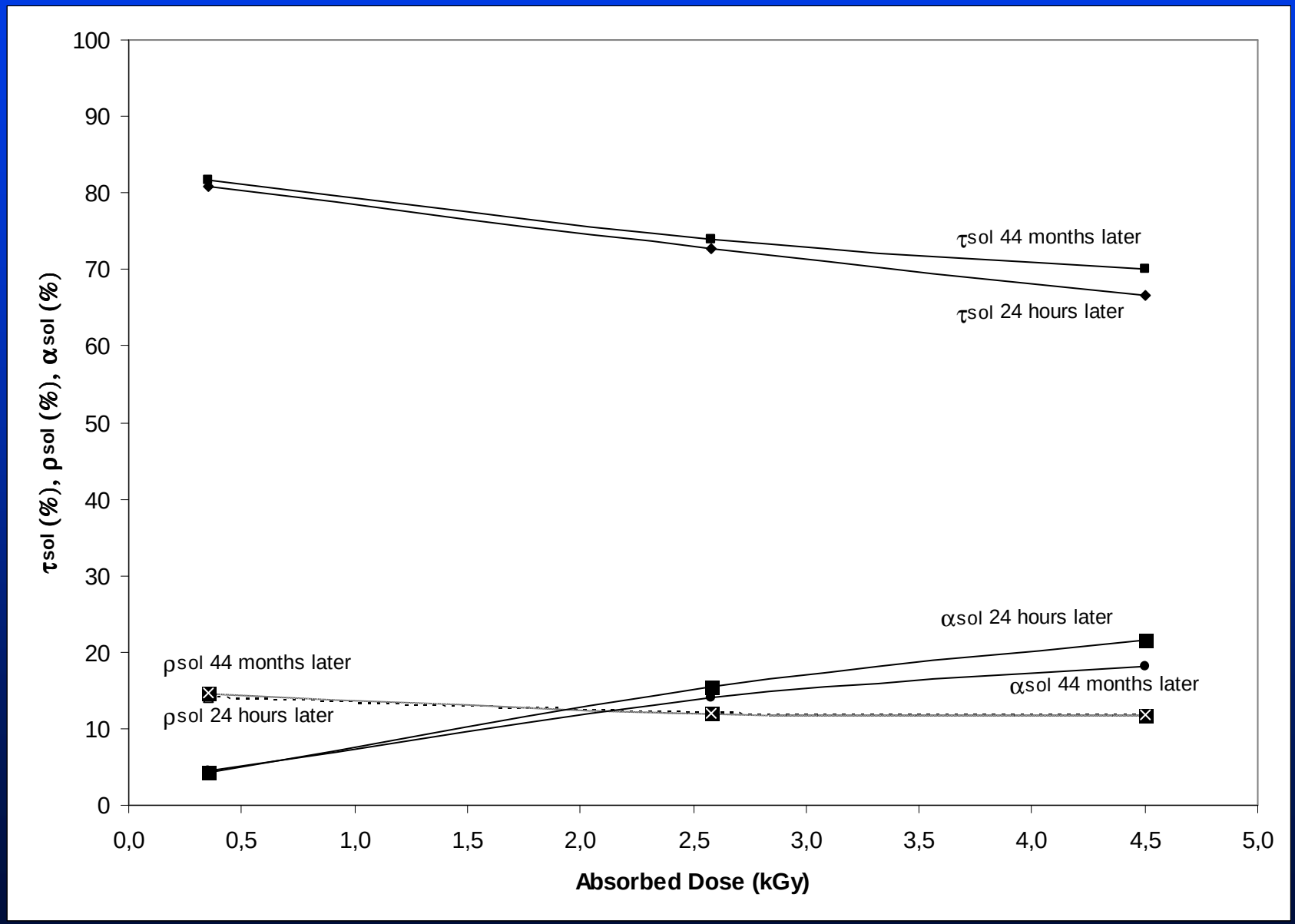
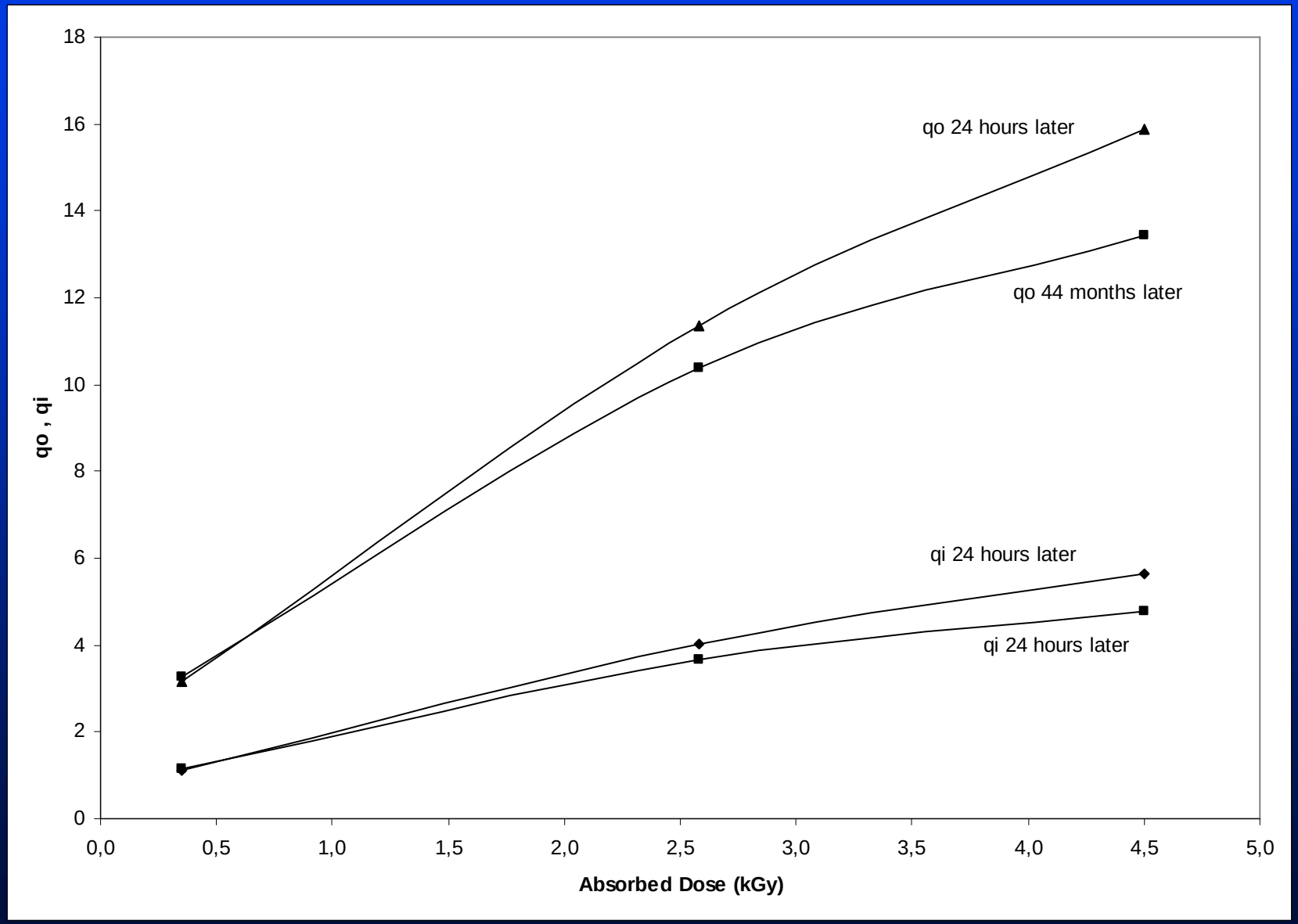


Fig. 3. Optical density of Ta_2O_5 films on Corning 2947 at doses of **(1)** 0.35 kGy by Co-60, **(2)** 2.58 kGy by Co-60, **(3)** 0.13 kGy by Sr-90, **(4)** 4.5 kGy by Co-60.

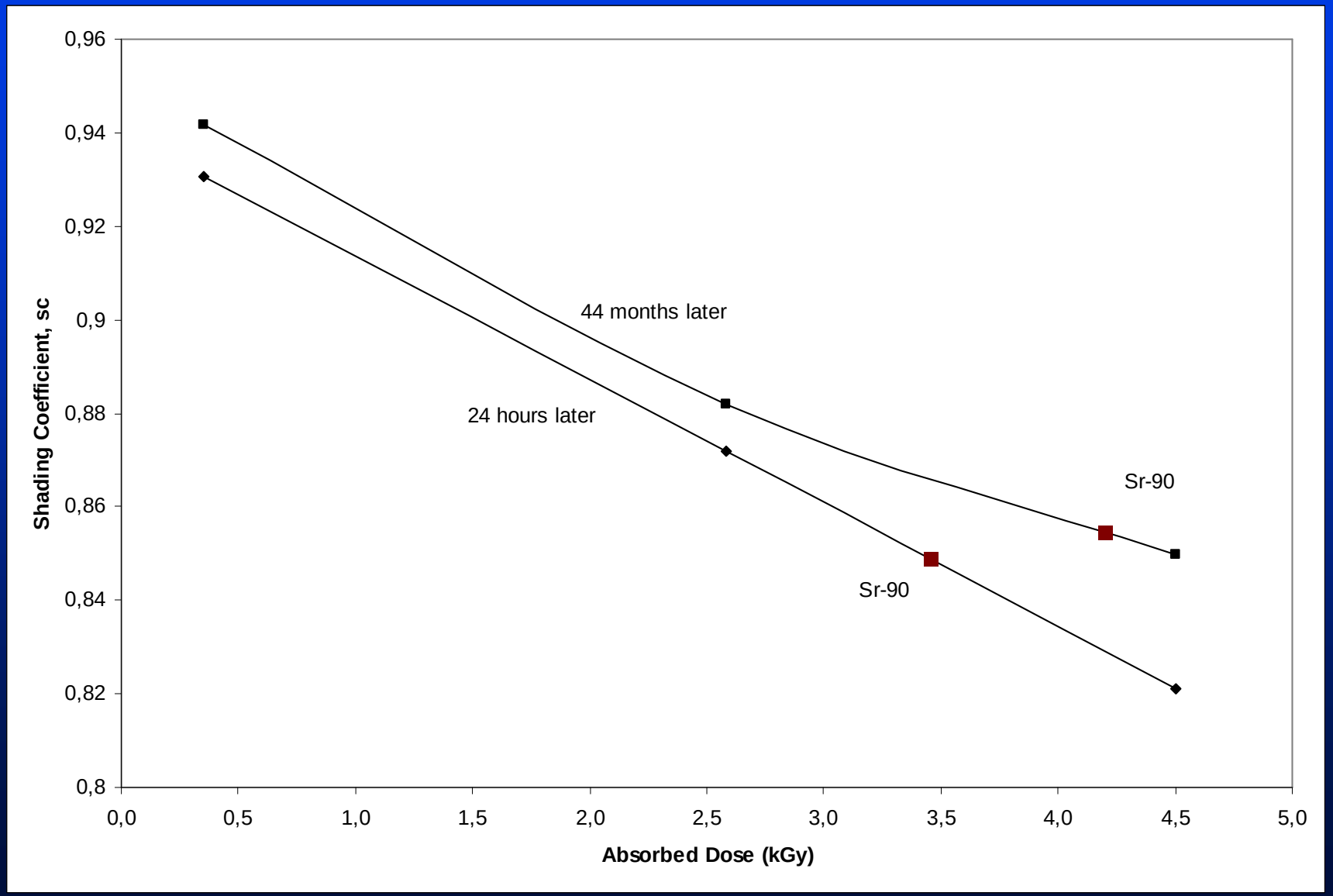
- For the evaluation of solar control mechanism of the test samples, the changes of solar properties via the absorbed dose were shown in **Fig. 4**.



- For the description of the transferred proportion of absorbed solar energy, secondary heat transfer factor of inside q_i and outside q_o was shown in **Fig.5**.



- The increase of the absorbed dose improved the shading coefficient in **Fig.6**.
- Shading ability enhanced depending on an increase of total solar heat transmittance and.



CONCLUSIONS

1. Changes at shading coefficient as the amount of heat passing through inside have related with the increase of induced colour centers at both Ta_2O_5 film and the glass structure.

2. Created color centers have changed the performance of shading coefficient considerably and improved shading coefficient has addressed the noteworthy gain in solar energy at Ta_2O_5 film on glass.

3. The best performance may be obtained from an irradiated Ta_2O_5 film on glass with a lower shading coefficient at a hot climate, special study conditions or experimental media.

4. The created band ~ 630 nm has addressed to the transition elements such as Zr, and Re from Corning 2947 glass substrate and Ta from Ta_2O_5 film. Besides, the changes of the optical density bands due to absorbed dose explained the causes of the enhanced coloration by induced color centers.

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