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Optical System for Testing High - Intensity Optical Filters and Welding Shield

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Abstract: ***In this paper, the author reports about a low - cost system developed by the authors to test high - intensity filters for optical and UV regions with due attention to the hazardous aspect of radiation to both the eye and imaging systems. For study purposes, the authors have selected a few standard filters and welding glass shields to observe high - intensity sources, full Moon, and welding arc flames. The author studied the standard filters' transmitted spectrum and intensity cut using the single slit, wavelength splitter (grating), and optical sensors (Web camera and Digital Lux Meter). In the next phase, the author developed optical filters at the Lab using semi - transparent materials like cellophane papers, polymers, thin metal Oxide - Spray - Coating, and their combinations. Based on the spectroscopic studies, the authors found the filters for Welding Shields and other High - intensity Optical Filters with clarity & relief to the eye of an observer.***

Keywords: Optical Filter, Transmission Spectroscopy, Diffraction grating

1. Introduction

Optical filters are commonly used in front of telescopes to selectively transmit one portion of the spectrum and reduce the intensity of the incoming radiation. Their purpose may be different on a case - to - case basis. In some cases, it is used to save the human eye from damage. In some cases, it may help in good vision of a source by filtering out the stray lights entering the eyepiece. It is positioned or fitted in front of the objective of the optical system to filter out a part of the radiation and selectively transmit the other portion. Depending upon the purpose different types of filter is designed for different purpose. Nowadays, they are commonly used in microscopy, spectroscopy, chemical analysis, and machine vision. In the present work, we have selected a narrow area to study the filters available for watching the very bright sources as well as wielding arcs.

2. Objective of the work

This work's main objective is to develop an experimental facility to study filters used for welding shields (3M, 2008) and high - intensity optical filters, as well as develop some high - intensity filters at the Lab using the material available in the market. We start with developing a process for making optical filters at the Lab using different materials and testing their efficacy.

In many places, the armature astronomers use Optical filters and the Sun glasses to view Solar eclipses, sunspots, and the Moon without testing as the testing facilities are unavailable. In recent years, in our Universities, many students and scholars have also been interested in seeing events like solar eclipse, Sun Spot, and Moon. In this connection, we want to provide testing facilities and experimentally tested filters for safe viewing of the different solar and lunar events. Moreover, it will also open a scope for the workers involved in welding to test the performance of their welding shields.

3. Experimental Design and Data Collection

Figure 1, 2, and 3 depicts the overall methodology of the work. The present work is done following these three motives.

a) Development of an optical system to test the filtration capacity of the filters used for witnessing and imaging the sun, full Moon, welding flame, etc
b) To develop new optical filters using a combination of the different semi - transparent materials and film available in the market and
c) To test some of the filters using the system designed in the Lab.

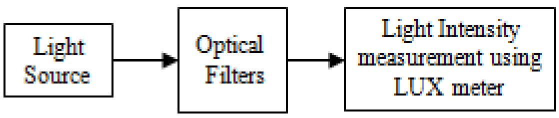

Figure 1: Experimental setup to measure intensity reduction

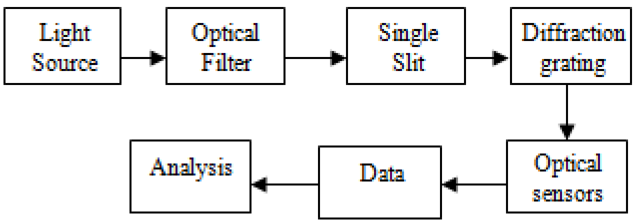

Figure 2: Experimental setup to diffraction spectrum

Method

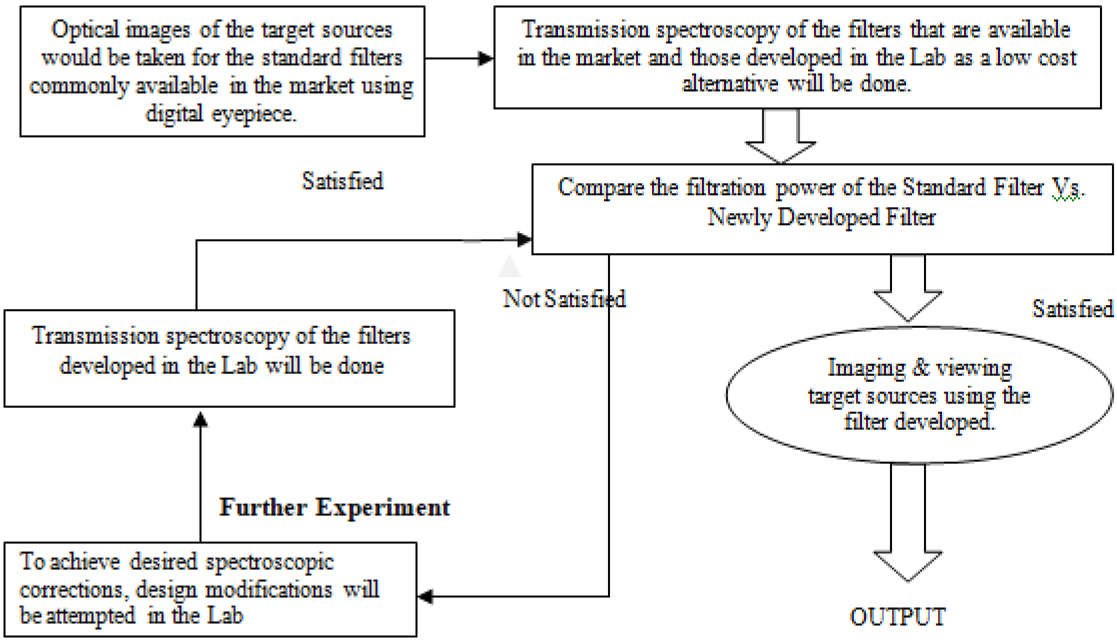

Figure 3: Block diagram of the methodology used for the work

4. Experimental result and discussion

4.1 Illuminance studies using LUX meter

We have used HTC Lux meter (LX - 101A) to measure intensity reduction as described in Table 1. Without any filter, the **illuminance is** 3550 Lux. For each measurement, we have waited until there is no illuminance fluctuation in the Lux meter. In some samples, we observed that we have to wait a lot to get the constant value in Lux meter; the same is mentioned as slow.

S. No.	Sample code	illuminance in Lux	Reduction in intensity (R_i)	Image Clarity*	Spectrum Study
1	Gl_Gr	638	18	Clear, visible	Yes
2	PP_SDBlaF	10	0.28	clear/faint	Yes
3	PP_SLBlaF	944	26.59	Clear & Very bright	No
4	PP_SBluF	334	9.41	Clear, visible	Yes
5	PP_SSlivF	12	0.34	clear/faint	Yes
6	PP_SGoldF	41	1.15	Clear, visible	Yes
7	PP_SCuF	605	17.04	Clear, visible	Yes
8	PP_SGold_Sp	1102	31.04	poor	No
9	PP_DLBlaF	291	8.2	Clear, visible	Yes
10	PP_DBluF	47	1.32	Clear, visible	Yes
11	GG_SolarF (standard)	0.5	0.01	Clear /faint	Yes
12	PP_DMBlaTap	19	0.54	Clear, visible	Yes
13	PP_SSilFoil	55	1.55	poor	No
14	PP_DDBlaTap	0.8	0.02	Faint	Yes
15	PP_SDBlaTap	37	1.04	Clear, visible	Yes
16	Gl_Gr_SBlaTap	10	0.28	faint/Clear	Yes
17	Gl_Gr_DBlaTap	0.2	0.01	Very faint	Yes
18	Gl_Weld (Standard)	0.2	0.01	Very Faint	Yes
19	B2_Gl	177	4.99	Clear, visible	Yes
20	B2_Fibre	553	15.58	Clear, visible	Yes
21	Celestron Moon	82	2.31	Clear, visible	Yes
22	Celestron_filter_80A	1506	42.42	Clear, visible	Yes

Based on our study, we group them in four categories based on reduction in intensity of light.
Group - 1 (R_i, <0.5): PP_SDBlaF, PP_SSlivF, GG_SolarF, PP_DDBlaTap, Gl_Gr_SBlaTap, Gl_Gr_DBlaTap, Gl_Weld
Group - 2 (10<R_i<50): Gl_Gr, PP_SLBlaF, PP_SBluF, PP_SCuF, B2_Fibre, Celestron_filter_80A
Group 3 (4.0 < R_i<10.0): PP_SBluF, PP_DLBlaF, B2_Gl
Group 4 (0.5 <R_i<4.0): PP_SGoldF, PP_DBluF, PP_SDBlaTap, Celestron Moon

We have chosen a few of the group - 1 optical filters (high - intensity filter) for diffraction spectrum studies (Likith et al., 2021).

4.2 Diffraction Spectrum Study Using Spectrometer

For this purpose of the same, we have designed a modified version of the Spectrometer described by Theremino Spectrometer Construction (Theremino Spectrometer

Construction, 2014) in which we have used a webcam of 1080P, Hilger & Watts diffraction grating having 15000 L. P. I and the Single Slit. We have used UV Basking heat light bulb - 75 watt as the source. The block diagram of the experimental setup to the diffraction spectrum's block diagram is shown in Figure 2 and the results of the study are mentioned in Figure 4 - 11. We have used the Theremino spectrometer - Tool for a spectrum analyzer (Theremino Spectrometer Construction, 2014).

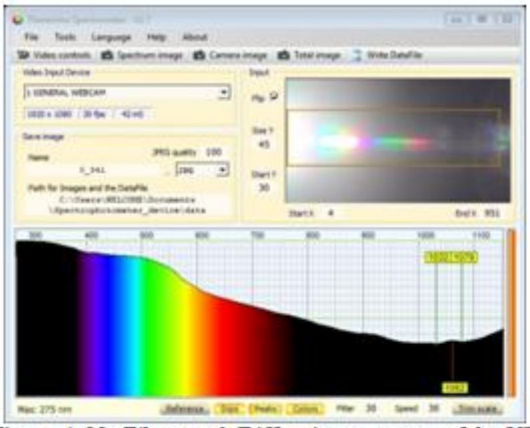

Figure 4: No Filter used, Diffraction spectrum of the UV Basking heat light, which is used as the source

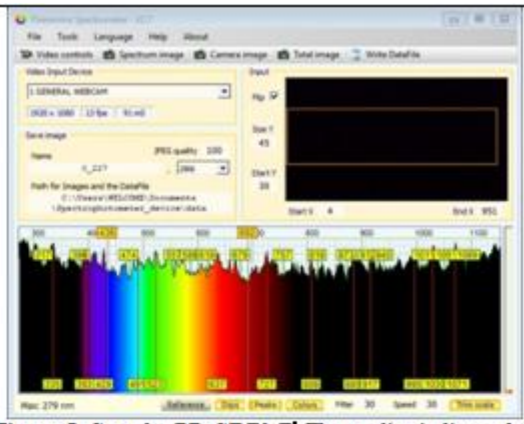

Figure 5: Sample: PP_SDBlaF, The studies indicate that the filter with code PP_SDBlaF is suitable for use as a radiation shields for welding

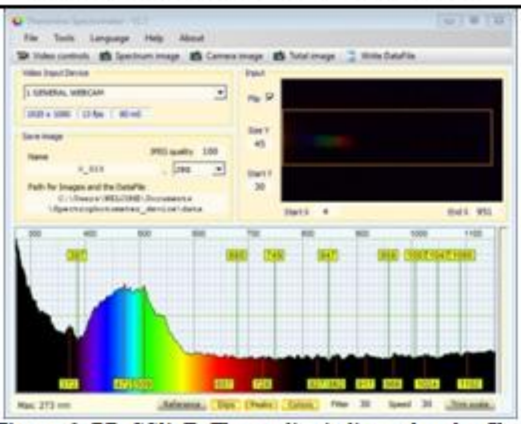

Figure 6; PP_SSlivF, The studies indicate that the filter with code PP_SSlivF is not suitable for use as radiation shields for welding (Figure 3)

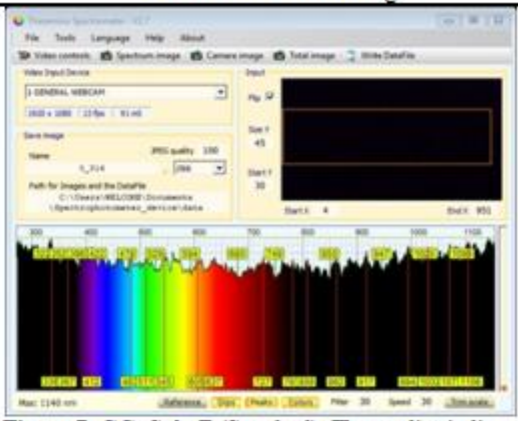

Figure 7; GG_SolarF (Standard), The studies indicate that the filter with code GG_SolarF is suitable for use as radiation shields for welding (Figure 4)

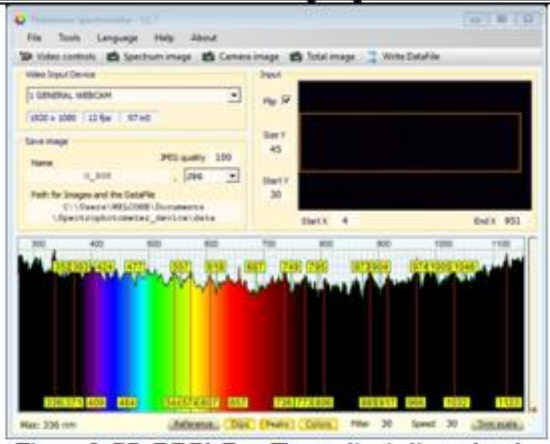

Figure 8: PP_DDBlaTap, The studies indicate that the filter with code PP_DDBlaTap is suitable for a welding radiation shield for welding.

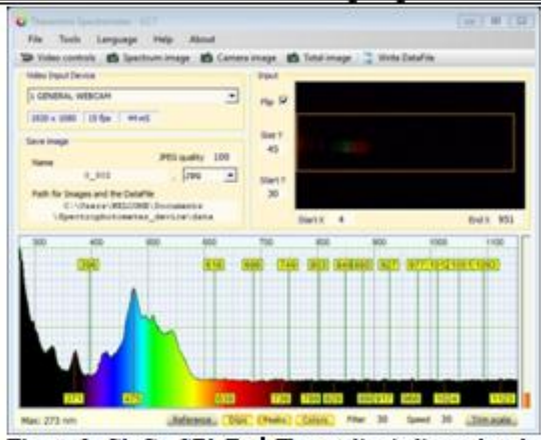

Figure 9: Gl_Gr_SBlaTap, The studies indicate that the filter with code Gl_Gr_SBlaTap is not suitable for use as a radiation shield for welding

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