Finding Neon: Measuring the Color and Light Output of Neon Tubes

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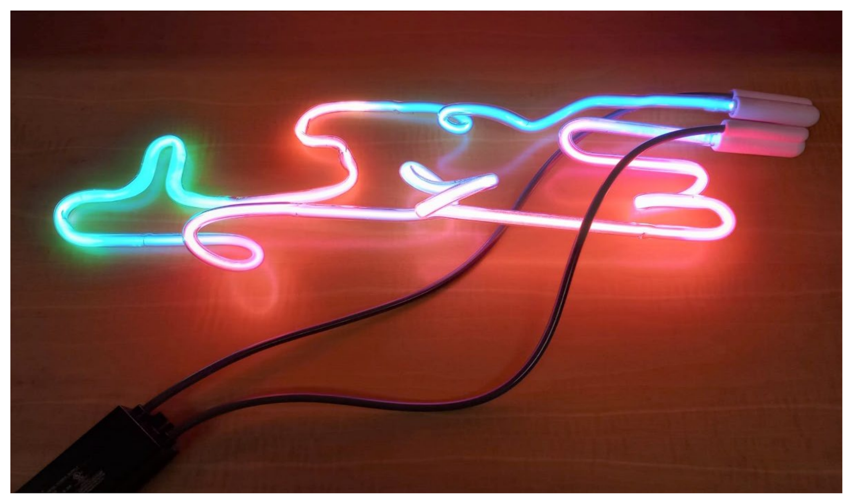
Gas-filled luminous tubes, known as "neon tubes", are employed in art installations and commercial signs. The photographic documentation of neon is notoriously challenging due to its dramatic variance in brightness and the color and brightness shifts that occur gradually over its lifespan. This heightens the importance of documenting color and brightness at a moment when their appearance is considered acceptable. This study looks at practical considerations of using spectrometers to do so, and is part of a more comprehensive research project at the Getty Conservation Institute on the care of light-based artworks.

NEON LIGHTING TECHNOLOGY

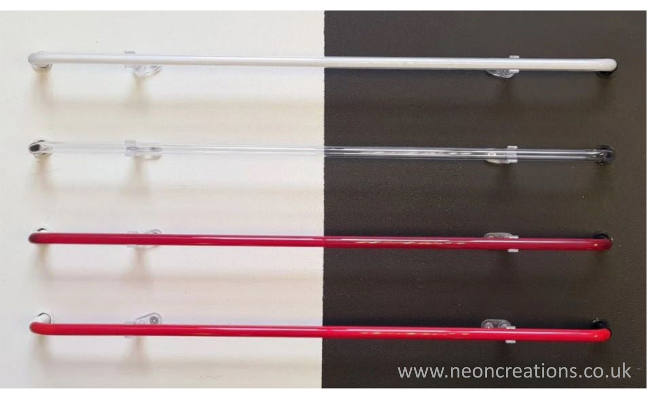
Neon lights are made of four essential components: the sealed glass tube, the gas contained in the tube, the electrodes at either end, and the transformer, which delivers high voltage. When the light is turned on, the gas is brought to a state of excitation and glows; this happens because gas charged atoms emit photons due to the electrons' energy absorption and release.

Colors are achieved through the following materials:

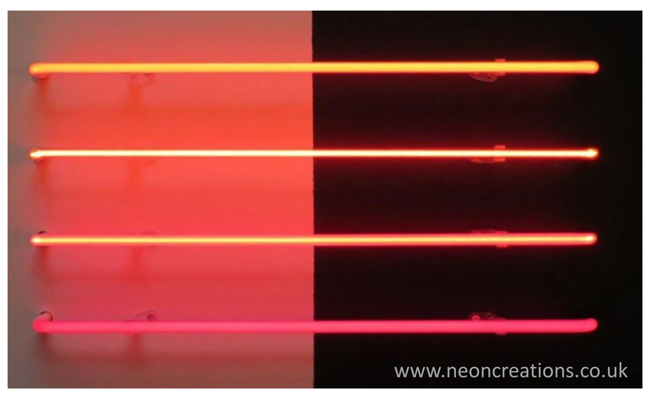
- Gas fill: noble gases, sometimes mixed together, produce characteristic colors and intensities.
- Glass body: glass can be colorless or colored by metal oxides added during its manufacturing process.
- Phosphor coating: a layer of fluorescent phosphors on the inside of the tube converts UV radiation emitted by the excited gas into a visible light.
- Paint or gels applied to the outside of the tube.



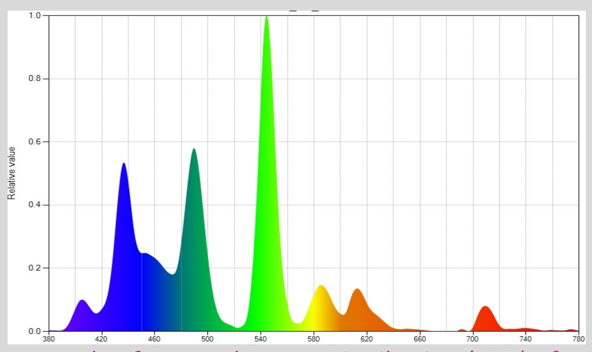
clear glass unit with different phosphor coatings



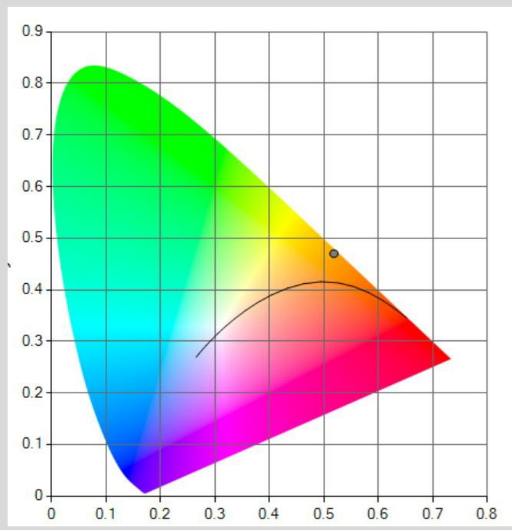
clear glass – phosphor coated
clear glass – uncoated
colored glass – uncoated
colored glass – coated



Gas	Color
Neon	red-orange
Helium	orange
Argon	dim pink-purple
Krypton	dim gray-green
Xenon	dim gray-blue



example of Spectral Power Distribution (SPD) of a commercial blue unit



example of Chromaticity measure of a commercial yellow unit(CIE 1931)

NEON LIGHT MEASUREMENT

After literature-based research and consultation with conservation professionals and neon art stakeholders, a variety of spectrographic instruments were identified to compare, based on:

- Affordability
- Whether they provided the following data:

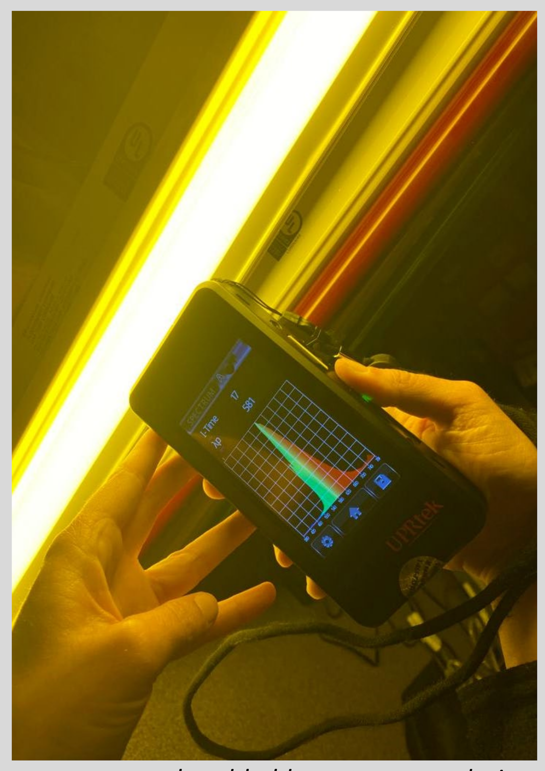
→ Spectral Power Distribution (SPD), which shows the energy levels at each wavelength of the light spectrum. Each color (and gas) has a distinct SPD "fingerprint".

→ Chromaticity, representing light color coordinates in the CIE 1931/76 color space diagrams; this is helpful for documenting color shifts.

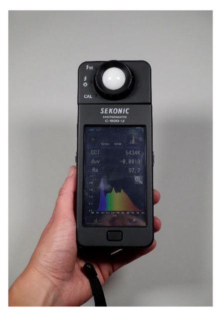
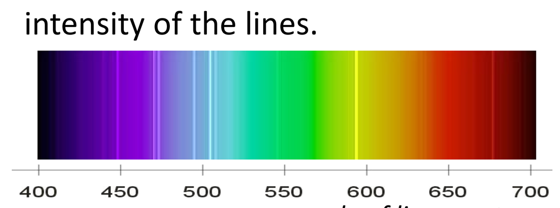
→ Illuminance, the amount of visible light the source puts out (in lux or foot candles).

WORKFLOW

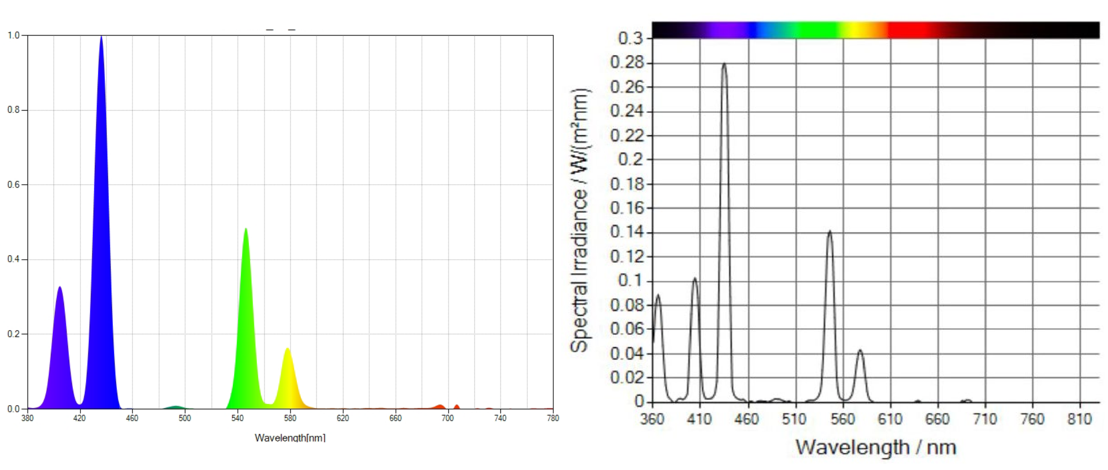
- The object should be measured in a dark space; all light sources such as lamps, openings, and windows should be turned off or blocked.
- Position neon unit and turn it on for 20 minutes in advance of the measurement (this gives the gas in the unit time to reach equilibration inside the tube).
- Start the instrument and its PC software or mobile app, if necessary (see table below); launch dark calibration if prompted on the display interface (for overall instrument calibration, interval check recommendation from manufacturer to schedule appropriate maintenance by the company or other supplier).
- Identify the locations for measurement and document the spots selected by marking them on a photo or diagram of the work.
- Block surrounding light from the unit itself, using black cloth; this is especially important if the neon tube has different color sections, which will affect the measurements.
- Perform the measurement placing the instrument in contact with the glass tube and keep track of the acquired files name or time; written notes or a picture can be saved in the file only for some instruments.
- Download data from the instrument, if acquired remotely, and store in the artwork's file
- Repeat the process, as possible, throughout the neon unit's lifetime. Colors will shift more quickly at the beginning of a unit's lifetime.



hand-held spectrometer during measurement

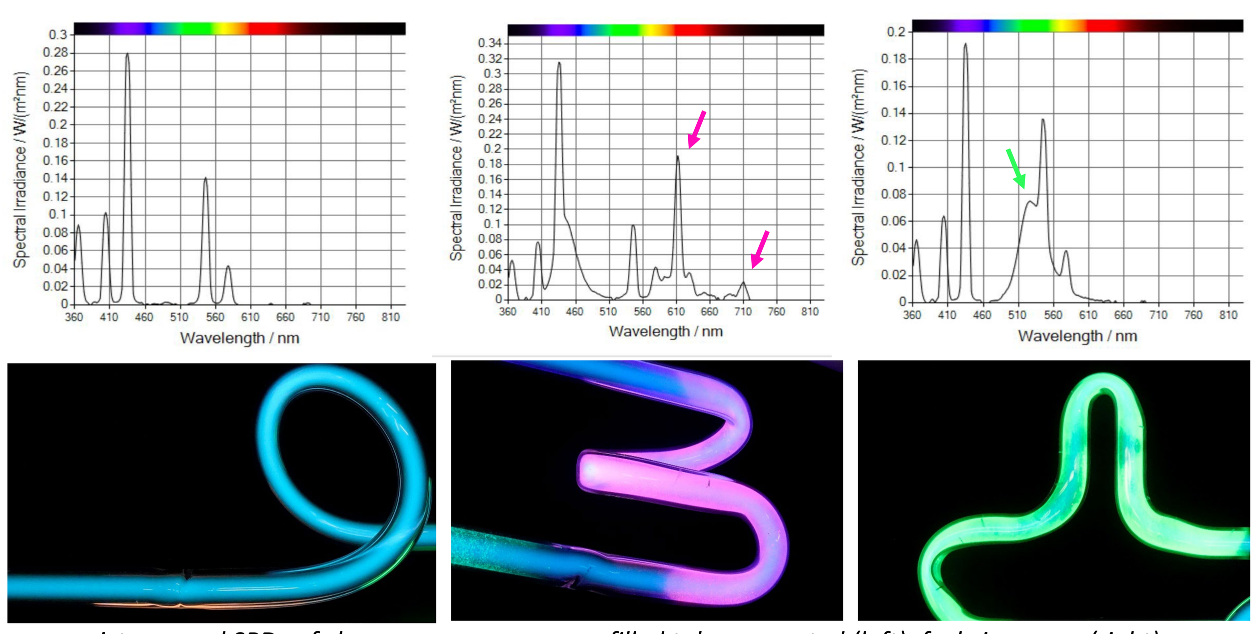
SPECTROMETER COMPARISON	UPRtek MK350S	AsenseTEK Lighting Passport	Gigahertz-Optik MSC15	Sekonic C-800-U	Hopoocolor HPCS-300-P	analog spectroscope
						
PRICE	$ 3751 (uprtek.com)	$ 2295 (estore.ushio.com)	$ 1970 (gigahertz-optik.com)	$ 1659 (sekonic.com)	$ 700 (amazon.com)	Using an analog spectrometer, data must be recorded manually after viewing the line spectrum in the viewer. Here, a wavelength bar corresponds with digital SPD diagrams *x* axis: pointing the detector to the light, spectral emission lines will appear. Use a blank spectrum graph to report each measurement, including information on thickness and intensity of the lines.  *example of line spectrum* PROS: - inexpensive - doesn't require software - no need of maintenance operations CONS: - limited data provided – no relative intensity/irradiance, narrow range - data documentation must be done manually, drawing lines distribution and intensity in the spectrum
SOFTWARE FUNCTION	uSpectrum PC software → to process data (not necessary)	Spectrum Genius Mobile → to run measurement and view data instantly	S-MSC15 PC software → to download and access data from PC	C-800-Utility PC software → to download data from the meter	OHSP 350X PC software → to run measurement and view data instantly	
PROVIDED DATA AND FORMAT	- SPD graph 380-780nm (JPG) - CIE1931/76 graphs (JPG) - CCT, Illuminance, CRI, CIE1931/76 coordinates, spectral data (Excel XLS)	- SPD graph 380-780nm (PNG) - CIE1931/76 graphs (PNG) - CCT, Illuminance, CIE1931/76 coordinates (email body text)	all data in proprietary format: - SPD graph 360-830nm - CIE1931 graph - CCT, Illuminance, CIE1931/76 coordinates	- SPD graph 380-780nm (JPG) - CCT, Illuminance, CRI, CIE1931 coordinates (Excel CSV)	- SPD graph *350-800nm* (proprietary) - CIE1931/60/76 graphs (proprietary) - CCT, Illuminance, CRI, CIE1931/60/76 coordinates, spectral data (Excel XLS)	
PROS	- CIE1931/76 graphs - SPD numerical data - immediate comparison between two graphs - easy visualization and download of data - light receptor at top edge permits access to LCD touch display - untethered measurement	- CIE1931/76 graphs - picture of the object can be included - comparison between graphs - size allows practical handling - mount support for smartphone	- CIE1931 graph and CIE1976 coordinates - broader spectral range - written notes can be included when run wired, which helps distinguishing measurement locations - LCD touch display also for untethered measurement	- easy visualization and download of data - immediate comparison between two graphs - untethered measurement - LCD touch display	- CIE1931/76 graphs - SPD numerical data - broader spectral range - price - small size allows measurement in difficult locations	
CONS	- lack of data below 380nm and above 780nm wavelengths - files must be saved separately, and download is slow when SD card is full - price	- lack of data below 380nm and above 780nm wavelengths - lack of SPD numerical data - long download process - necessity of iOS device - uncertain future technical support **(production suspended)**	- only proprietary file format - lack of SPD numerical data - slow data saving and unpractical operation when unwired (wired requires two people for time efficiency)	- lack of CIE1931/76 color space graph - lack of SPD numerical data - lack of data below 380nm and above 780nm wavelengths - big, round, and protruding light receptor limits contact with tube and can pick up ambient light	- necessity of wired connection to a computer to run measurement - lack of information materials in the kit and difficulty to find online, including PC software (must be requested to the supplier after purchase) - graphs only in proprietary program - tethering required	

Neon lights emit UV radiation, and thus have characteristic peaks in the UV-portion of the spectrum, that are only captured by spectrometers with broader range



SPDs of clear, uncoated neon+mercury gas-filled tube: the Gigahertz-Optik MSC15 diagram (right) shows a peak under 380 nm, not visible in data from Sekonic C-800-U (left)

Phosphors will add distinct peaks in SPD



pictures and SPDs of clear neon+mercury gas-filled tube: uncoated (left), fuchsia, green (right)

Many instruments do not provide SPD data, though it can be pulled off the graph using a plotting program. Various free options are available online.

Web Plot Digitizer

ACKNOWLEDGEMENTS

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Scan QR code for selected references

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