

Gemstones Enhancement By Nuclear Techniques

KIND CONTRIBUTION
FROM
GEMS IRRADIATION CENTER

THAILAND INSTITUTE OF NUCLEAR TECHNOLOGY



Gemstone Enhancement

**Heat, Irradiation, Impregnation, Dyeing
and other Treatments which alter the
Appearance of Gemstones and the
Detection of such Treatments**

Kurt Nassau, Phd.

Irradiated Gemstones



- 1909 W.Crookes changed color of diamond to green by irradiation treatment with Radium .



- 1957 Pough reported the color change in Topaz from colorless to blue, when it was irradiated.



- 1986 Office of Atoms for Peace (OAP) conducted the experiment on Gemstone Irradiation.



- Since 1989 OAP has been serving the customers on the Blue Topaz by Neutron treatment and Gamma Irradiation for Tourmaline

Rays and particles used for the irradiation of gemstones

- **Gamma Rays**
from Co-60 source
- **Neutrons**
from research reactor
- **Electrons**
from electron accelerators



Gamma Source

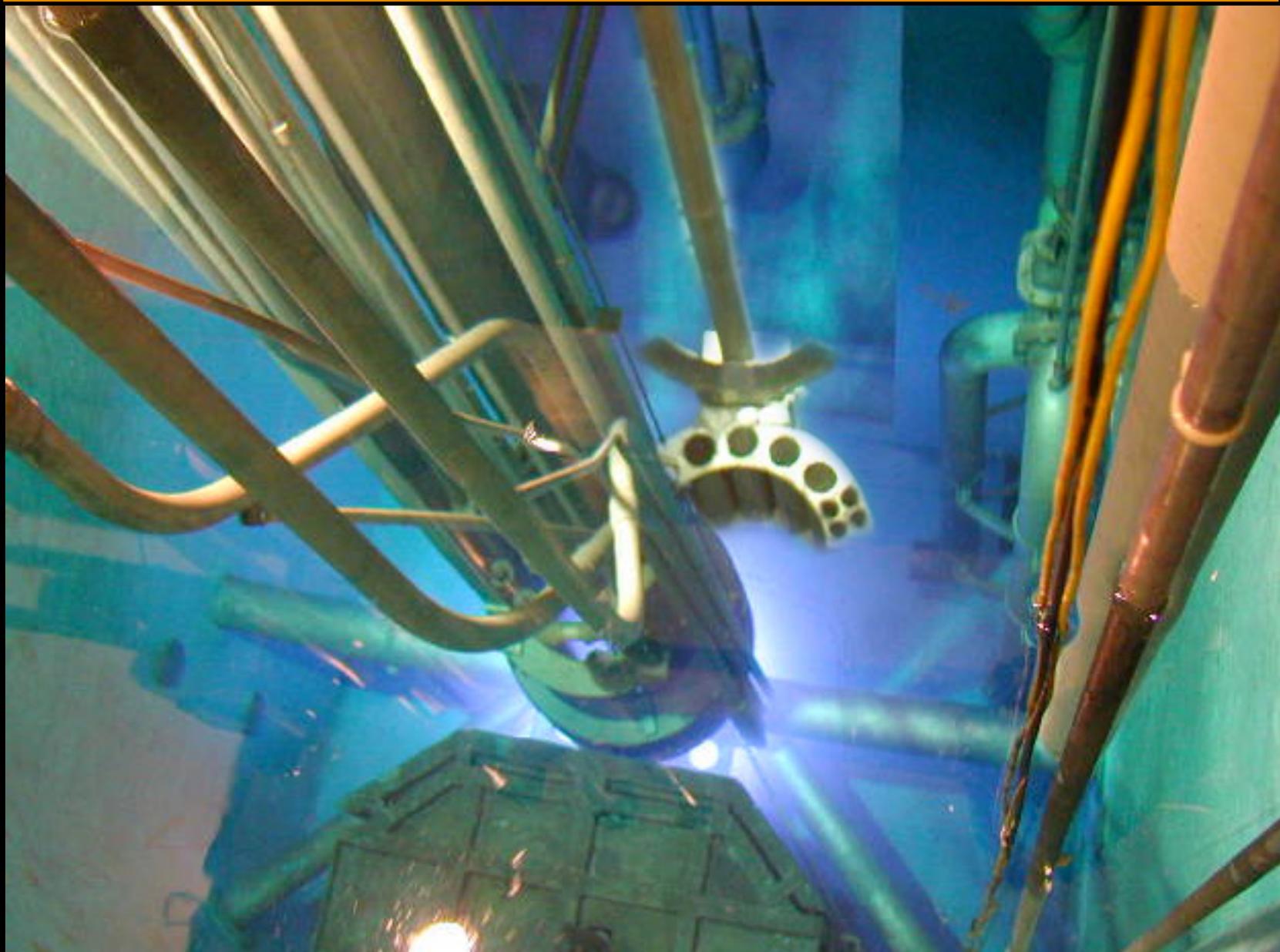


A sample being loaded into a cobalt 60 gamma-irradiation unit by the author; when the doors are closed, the holder is lowered down into the cell. Photograph by courtesy of Bell Laboratories



GAMMA CELL 220 At TINT
Gamma Rays from Co-60 source
Activity : 23,859 Ci

Thai Research Reactor-1/Modification 1



Electron Processing System (EPS)



Photograph by Courtesy of MEVEX

Causes of color

- ◉ **Impurity**
- ◉ **Color Center**
- ◉ **Charge Transfer**

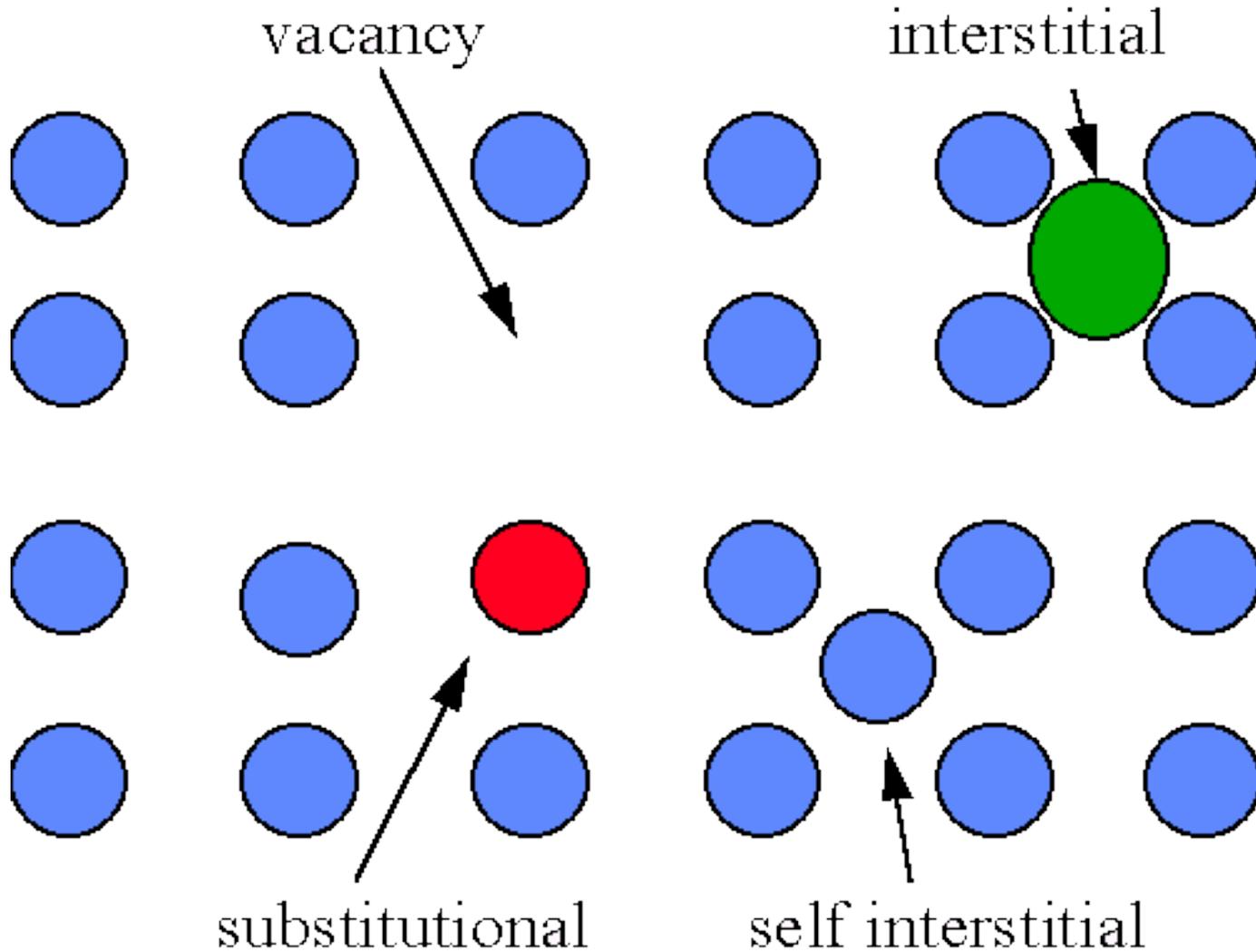


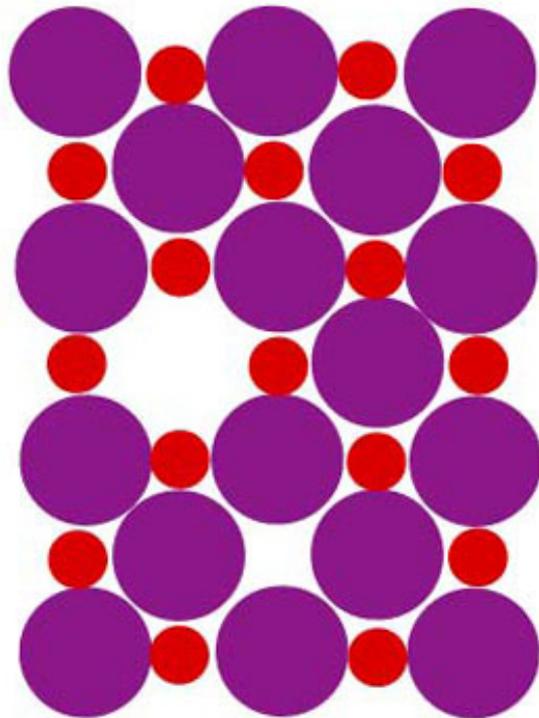
◉ Impurity

Example: Titanium (Ti), Vanadium (V),
Chromium (Cr), Iron (Fe),
Manganese (Mn), Cobalt (Co),
Nickel (Ni), Copper (Cu)

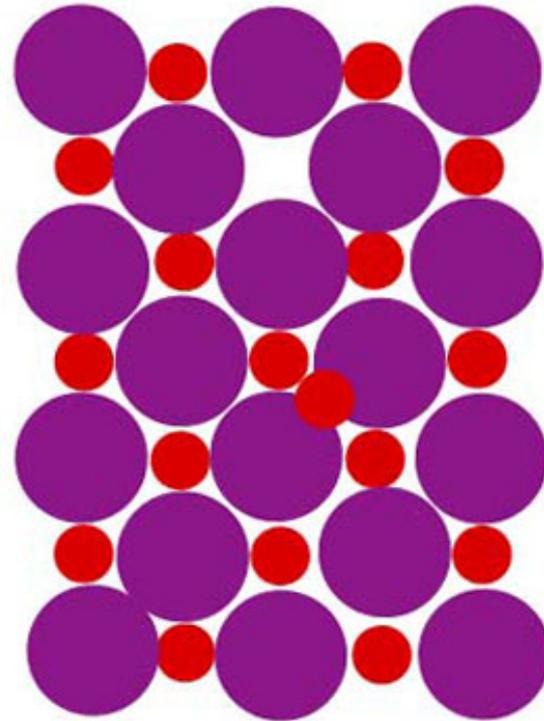


◉ Color Center : defect and dislocation



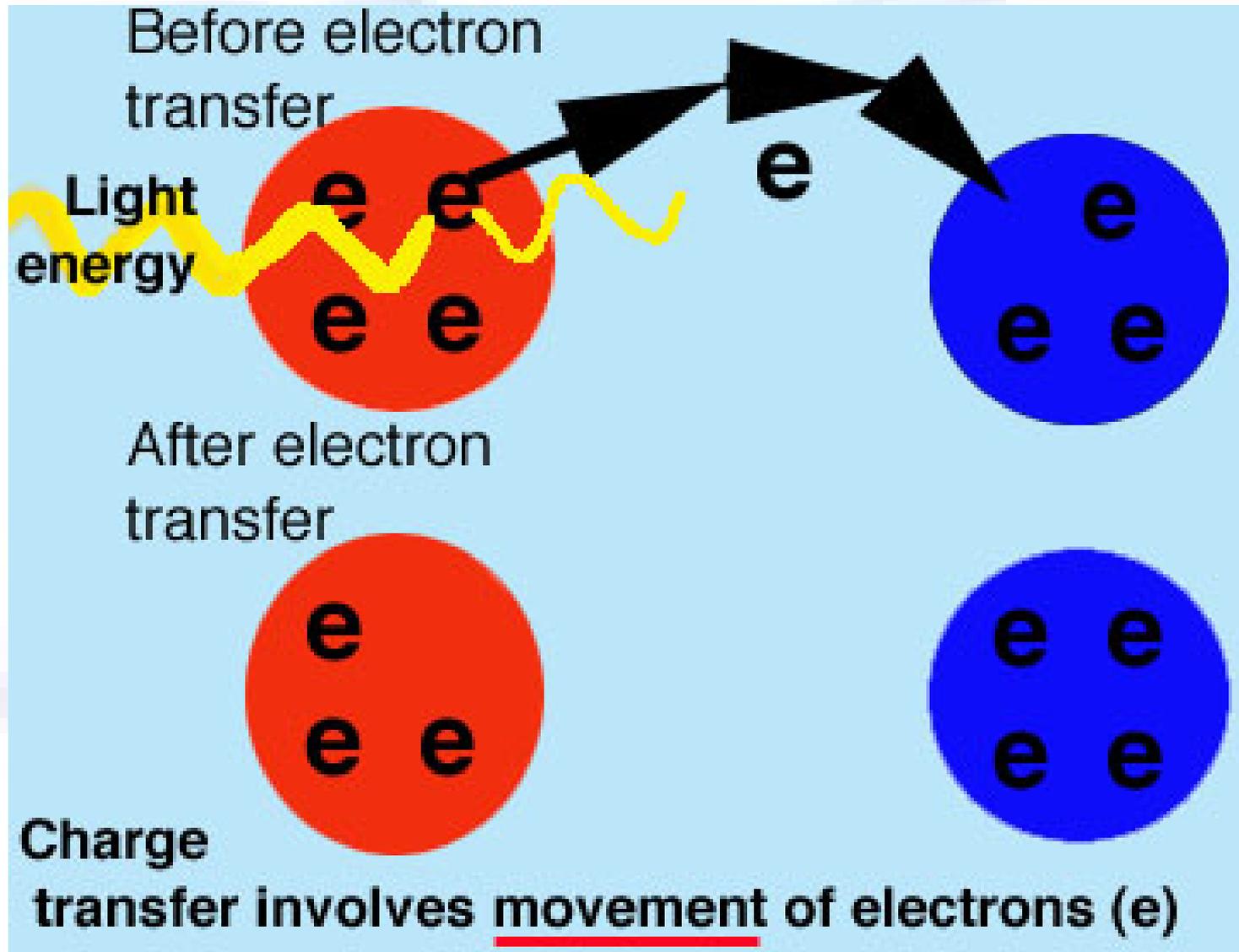


1 cation : 1 anion missing
(Schottky defect)



cation is missing from its
site, but is located elsewhere
in the structure (Frenkel defect)

◦ Charge Transfer



The major changes on irradiating gemstones

<u>Material</u>		<u>Changes</u>		<u>Stability</u>
Topaz		Blue or yellow		Stable
Tourmaline		Dark pink, purple, green		Stable
Quartz		Smoky or black		Stable
Beryl		Yellow or green		Stable
Aquamarine		Green, yellow		Stable
Corundum		Dark yellow		Unstable
Ruby		Not Change or Orange		Unstable
Jade		Dark green		Stable
Kunzite, Morganite		Green		Unstable
Zircon		Brown to reddish		Stable
Diamond		Green Yellow, Orange (heat)		Stable Stable

PROCEDURES TOPAZ ENHANCEMENT BY GAMMA IRRADIATION



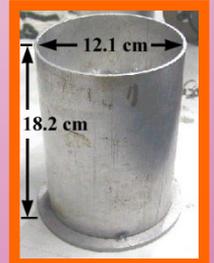
1. Colorless Topaz



2. To wrap by aluminum foil



3. Put in Aluminum Container



4. Irradiate with Gamma Cell 220



5. Color Check



6. Brown Topaz



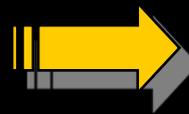
Irradiated Gemstone By Gamma-ray



Topaz



Before



After



Initially colorless topaz gemstones turned various colors by irradiation; the orange and brown ones fade in light, the blue ones are stable. The blue stones have been heated to remove the brown color; the blue color is stable to light

Tourmaline



Before



After



Before



After



Pale blue tourmaline (center) surrounded by originally matching specimens with colors changed by irradiation, colors are stable to light



Almost colorless tourmaline turned a peach color by irradiation (center) and originally matching watermelon slices, one irradiated (right); colors are stable to light



Untreated cats-eye tourmaline (center), with two originally matching stones, one of which turned yellowish on irradiation (left) and the other a deeper reddish (right); colors are stable to light

Pearls



Pearls in the natural state (below) and irradiated (above); the dark colour is stable to light



Before



After

Kunzite



Kunzite in natural pink state (left) and irradiated (right); the green color fades rapidly in light



Before



After

Sapphire



Be- Diffusion Before
Irradiated



After Irradiated



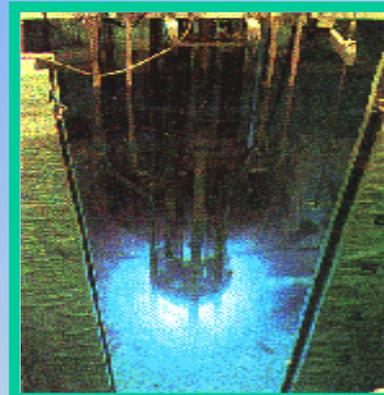
1. Colorless Topaz



2. Put in Aluminum Container



3. Put in wet tube



4. Irradiate in Reactor for 300-500 hrs.



5. Blue turning Topaz



6. Radiation Check



7. Blue Topaz



8. Safety Standard for customers below 2 nCi/g



9. Topaz without radioactivity

Topaz Enhancement by Neutron Irradiation



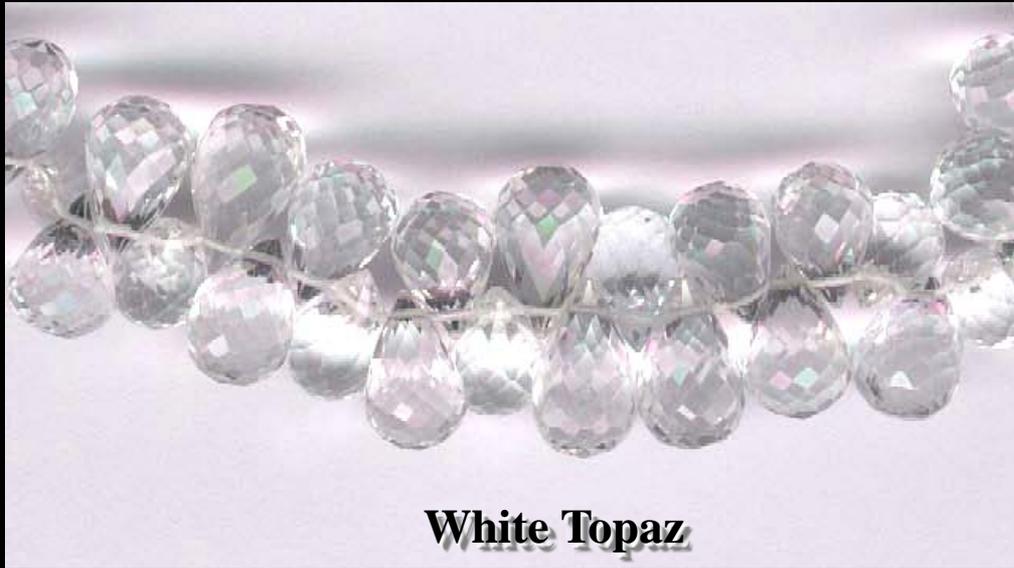
Natural Topaz



Neutron Irradiate

*Neutron and Electron
Irradiate*

Irradiated Topaz By Neutron+Electron Irradiation



White Topaz



Sky Blue Topaz



DIAMOND WHITE GOLD RING
London Blue Topaz



Swiss Blue Topaz

Increased Value

Neutron Irradiated Topaz: value increased by 5-30 times

Gamma Irradiated Topaz: value increased by 3-5 times

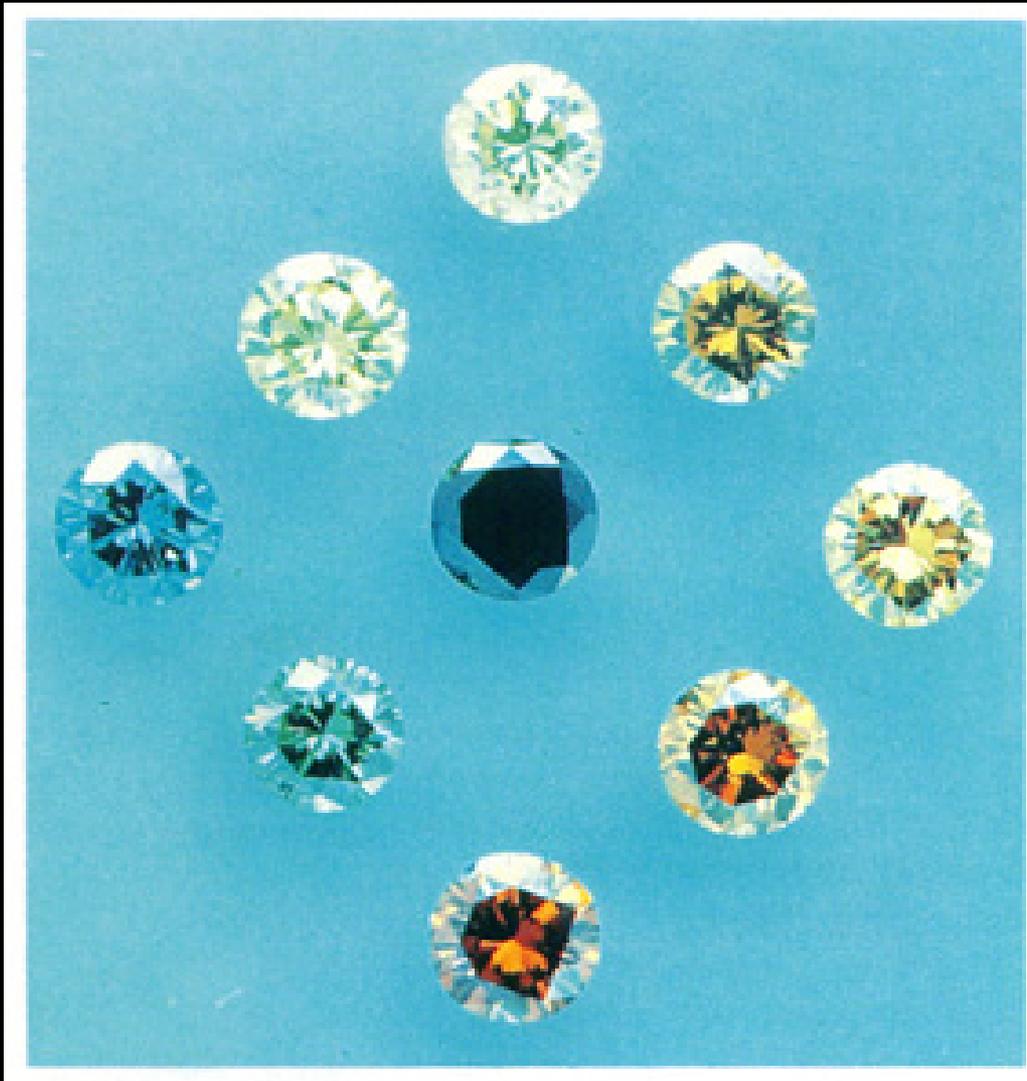
Item #TPZ444	
	3.62 ct.
	10.0x8.1mm Emerald Cut
	Medium
	Vivid Blue Green
	Loupe Clean
	[R] Neutron irradiated and/or heat treated.
	one of a kind
Blue Topaz	\$ 49.99 Add to Cart

Item #TPZ445	
	4.05 ct.
	10.1x8.2mm Emerald Cut
	Medium
	Vivid Blue Green
	Loupe Clean
	[R] Neutron irradiated and/or heat treated.
	one of a kind
Blue Topaz	\$ 49.99 Add to Cart



Neutron Irradiated Diamond with Heat Treatment





Originally near-colorless diamonds, some irradiated and some heated; colors are stable to light. Photograph by courtesy the Gemological Institute of America