

Ultraviolet Light Detecting Beads

UV-AST

A Simplified Explanation
by Ron Perkins

Ultraviolet Light Detecting Beads are usually observed indoors as white pony beads, with approximately 250 beads per bag. When exposed to sunlight or light from another UV source, the white beads change to many different colors (red, orange, yellow, blue, or purple). When the UV light is removed—e.g. walking inside a building—the colorful beads return to white. This cycle can be repeated hundreds of times.

Explanation



At the center of the colorless dye molecule is a carbon atom with four bonds that are arranged as far away from each other as possible. This is referred to as a tetrahedron carbon atom.

Attached to two of these bonds is a large planar group of atoms represented by the letter “A” on the lined paper shown at right. Another similar group of atoms, “B,” is attached to the other two bonds of the central carbon atom.

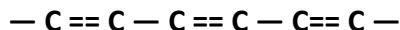


Both of these two groups of atoms “A” or “B” individually absorb short-wave light, but the individual groups are too small to absorb longer wave visible light. To us, the beads are seen as white.



When ultraviolet light is absorbed by the dye molecule, the two groups of atoms “A” and “B”—which had been at right angles—twist so that they are in the same plane. Groups “A” and “B” now can function as one large group of atoms, absorbing light in the visible section, ergo color!

The groups of atoms represented by the lined paper on the previous page are said to be conjugated. This simply means that the carbon atoms are connected with a series of single and double bonds.



Conjugated groups are known to absorb light. The larger the conjugated system, the longer the wavelength of light that is absorbed. Small conjugated systems absorb in the UV light as represented by our individual groups "A" or "B." Our eyes cannot detect this absorption.

When UV light hits the dye molecule of the pony beads, the small conjugated groups twist into a larger conjugated group. This larger conjugated dye molecule is now large enough to absorb certain specific frequencies of light in the visible spectrum. If the conjugated dye molecule absorbs violet light, we would see this as a red bead. Remember, white light is a mixture of all the colors, so if you remove violet light, the remaining colors will be seen as red.

If a chemist designs a molecule with an even larger conjugated system, the molecule can absorb red light, leaving behind a blue bead for us to see.

The dye molecules in the beads, when exposed to UV light, are continually changing from the tetrahedron shape to the planar shape. Heat from the room is also continually changing the planar molecule back to the tetrahedron shape. This is why you can cycle the change from white to colored to white to colored, etc.

Two conjugated smaller groups must be planar in order to form a single larger conjugated group which is the case in these Ultraviolet Light Detecting Beads when they are colored. If two conjugated groups are at right angles to one another, they act as two separate smaller conjugated groups, as in the white beads.

