

Safety: Laser Systems

Introduction

Most lasers used in our labs are capable of causing eye injury to anyone who looks directly into the beam or its specular reflection. In addition, diffuse reflections of a high-power laser beam can produce permanent eye damage. Laser beams can also ignite flammable materials (solvents, acetylenic compounds ...).

The equipment to run laser experiments may also introduce additional hazards: high voltage, toxic substances (laser dyes, precursors and their byproducts formed during the experiment, gases), vacuum (implosion of glass equipment) and gasbottles (high pressure).

Laser Dyes Hazards

Laser dyes are often toxic and/or carcinogenic chemicals dissolved in flammable, toxic solvents. This creates a hazard for personal exposures above permissible limits. To work with dye solutions means also to produce chemical spills (and fires).

The most hazardous aspect of a laser operation is the mixing of chemicals that make up the laser dye.

(source: NIH)

Little is known about the toxic properties of laser dyes, except that they are often members of chemical families that contain highly toxic materials.

Minor changes in the chemical structure of organic chemicals can have major effects on their toxic properties.

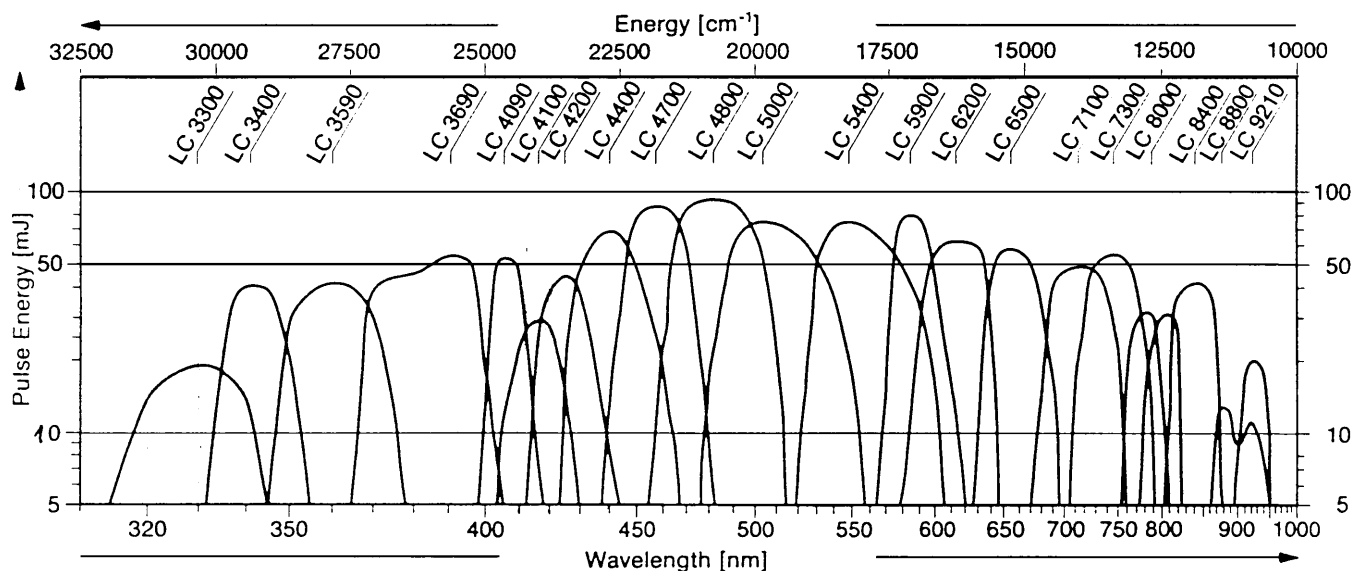
Animal experimentation has shown that laser dyes vary greatly in toxicity and potential carcinogenicity. Consequently, **all laser dyes should be treated as toxic chemicals** unless toxicological evidence to the contrary exists.

Given the structure of these compounds, a finding that a laser dye is mutagenic suggests that it may be carcinogenic as well.

Solvents

The solvent in which the dye is dissolved plays a major role in the hazards.

Most solvents for dye solutions are flammable and toxic by inhalation and/or skin absorption.



name	cas number	class	comments
BiBuQ / LC3860		M	unknown mutagenicity, unknown toxicity
BPBD-365 / LC3600	15082-28-7	M	unknown mutagenicity, unknown toxicity
coumarin 2/450 / LC4500		M	nonmutagenic, unknown tox.
coumarin 47 / LC4700		M	unknown mutagenicity, slightly toxic(rat LD50=3.85g/kg) possible reproductive hazard
coumarin 102 / LC4800	41267-76-9	S	strong mutagen, unknown toxicity
coumarin 120 / LC4400	26093-31-2	M	nonmutagenic, unknown toxicity
coumarin 153 / LC5400	53518-18-6	M	unknown mutagenicity, unknown toxicity
coumarin 307	55804-70-1	M	unknown mutagenicity, unknown toxicity
DCM / LC6500	51325-91-8	S	moderately strong mutagen, unknown toxicity
DMQ / LC3590		M	unknown mutagenicity, unknown toxicity
DPS / LC4090	2039-68-1	M	doubtful bacterial mutagen, unknown toxicity
PBBO / LC4000	17064-47-0	M	unknown mutagenicity, unknown toxicity
QUI / LC3690		M	unknown mutagenicity, unknown toxicity
rhodamine B / LC6100	81-88-9	M	nonmutagenic, moderately toxic (rat LDlo = 500mg/kg)
rhodamine 6G / LC5900	989-38-8	M	nonmutagenic in ames test, mutagenic in B subtilis assay, weak mammalian carcinogen NTP class 3 (no evidence in mice, equivocal evidence in rats), reproductive effects, metabolic inhibitor
rhodamine 101 / Lc6400	64339-18-0	M	unknown mutagenicity, unknown toxicity
sulforhodamine B/LC6200	2609-88-3	M	unknown mutagenicity, unknown toxicity
stilbene 3 / LC 4200		L	nonmutagenic, practically nontoxic
p-terphenyl / LC3400	92-94-4		serious irritant, slightly toxic(rat oral LD50=>10g/kg)
pyridine 1 / LC7100	87004-02-2	M	unknown mutagenicity, unknown toxicity
pyridine 2 / LC7300		M	unknown mutagenicity, unknown toxicity

- L:** limited control class: **practically nontoxic,relatively harmless. dyes are not mutagenic.**
(ethanol methanol and ethyleneglycol are solvents assigned to this class.)
wear safety eyewear.
- M:** moderate control class: **moderately toxic, highly toxic, or extremely toxic non mutagenic**
dyes with unknown toxicities are also placed in this class.
(solvents as DMSO and dioxane are classed as moderate hazards.)
wear safety eyewear, gloves and lab coat, mixing dyes in lab hood
posted as a dye-mixing area. promoting enclosure of the pump/filter.
- S:** strict control class: **mutagenic laser dyes and laser-dye solutions in this class are carcinogenic or potentially carcinogenic.**
eliminate all contact with substance.wear safety eyewear,gloves,lab coat and respiratory protection. mixing dyes in lab hood. dye handling and mixing areas are to be posted as mutagen work areas, and storage containers must be labelled as mutagen. enclosed dye-circulating pumps or filters are encouraged.
(facility and equipment guidelines in the strict control class are also more stringent–false floors are discouraged.)

dye/solvent mixtures with less than 1% dye shall be handled as appropriate for the solvent, with the exception that strict-class requirements for container and labeling shall be followed when strict class dyes are used. dye / solvent mixtures with more than 1% dye shall be handled as appropriate for the component having the strictest control class.

the ames test is a reliable predictor of whether a compound is a carcinogen in mammals, but it does not measure the potency of the carcinogen. thus, a weak ames mutagen could be a strong carcinogen. ames test data are used because animal testing is more costly and has not been done on most dyes.

rating	LD50 for rats
relatively harmless	>15 g/kg
practically nontoxic	5-15 g/kg
slightly toxic	0.5-5 g/kg
moderately toxic	50-500 mg/kg
highly toxic	1-50 mg/kg
extremely toxic	<1 mg/kg

(source: national institute for occupational safety and health u.s.gov wa dc 1973)

coumarines: some substances from the family of the coumarines are used to kill rats.

rhodamines: rhodamine dyes are used for coloring cells, what shows that they like to stick on organic material.they are also used for food coloring

DCM: 4-cyanomethylene-2-methyl-6-p-diethylaminostyryl-4-H-pyran (what an ugly whopper!?) is known as a mutagenic substance. given the structure of this compound,finding that it is mutagenic suggests that it may be carcinogenic as well.