NASA TECH BRIEF

Coolants with Selective Optical Filtering Characteristics for Ruby Laser Applications

One way to increase the pulse power output of a ruby laser is to increase the amount of pump radiation incident on the crystal. Two pumping techniques that have been commonly used primarily involve the radiation of large amounts of light in the ultraviolet region of the spectrum. Although, in general, the increase in ultraviolet light will give larger output pulses, a study has shown that the absorption of ultraviolet light of certain frequencies by the ruby is actually detrimental to peak power outputs. It is essential therefore to find a suitable means of filtering the unwanted frequencies. Another major problem in the operation of ruby lasers is crystal heating during the pumping period. Although the vapors from liquid air and liquid nitrogen have been used to cool the crystals in the past, a liquid coolant that filled the area between the flashtube (usually xenon filled) and crystal would have several advantages. In view of these considerations, a research study was undertaken to find a suitable liquid that would serve both as a coolant and as a medium for filtering out undesirable flashtube emissions.

The coolant-filtering medium developed as a result of this study consists of a solution of copper sulfate in a 4:1 volumetric mixture of ethanol and methanol. This solution should be a useful addition to ruby laser systems, particularly in large pulse or Q-switching applications, which experience the greatest harmful effect of the far ultraviolet flashtube emissions. The properties of the solution can be easily adjusted, as the absorption of the ultraviolet is performed by one component (copper sulfate) and the cooling is effected by other components (ethanol–methanol). Thus, the amount of ultraviolet absorption can be varied by merely changing the copper sulfate concentration in the solution. A principal feature of this medium is its ability to absorb all wavelengths below 3,000 angstroms while at the same time remain almost transparent to light in the pump band regions for the ruby crystal. For example, with copper sulfate concentration large enough to absorb all wavelengths below 3,000 angstroms for a given optical path length, it was found that the transmittance of light in the frequency range of the ruby pump bands was reduced only a few percent. While the coolant does absorb the ruby emission to a slight degree, this problem can be entirely avoided by proper design of the coolant housing.

The components of the solution are commercially available at low cost and are easy to handle. This solution should have high chemical stability, since the energy absorption process involves only one element and not the bond configuration of a molecule. While the solvent absorbs to some degree in the far ultraviolet, the copper sulfate solute has a much more intense absorption in this region and should prevent any short-term decomposition of the solvent.

Notes:

1. It is likely that another solvent liquid for copper sulfate could be found that would have better coolant properties than the ethanol–methanol mixture.
2. Documentation for the innovation is available from:
   Clearinghouse for Federal Scientific
   and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: B68-10508

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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