**R&D 100** WINNER

# 1998 R&D 100 Awards Winner
## Low-Smoke Pyrotechnics

**Features**

Combining an energetic, nitrogen-rich fuel with nonmetallic oxidizers and unprecedentedly low levels of metal coloring agents, our new pyrotechnic mixtures produce clean flames that generate virtually no smoke or ash. Our mixtures enhance the deep, bright colors typical of traditional pyrotechnics and offer a reliable alternative to black-powder-based propellants at a reasonable price. A thousand years after the invention of black powder, our mixtures make it possible for the first time to produce spectacular fireworks of any size that are safe and effective in either indoor or outdoor settings.

**Applications**

Our low-smoke pyrotechnic mixtures are currently designed for
- indoor fireworks—stage fireworks used for entertainment in theatrical productions, films, and rock-and-roll concerts; stage or aerial fireworks used for celebration at political rallies and sporting events; and table-top fireworks used for education in chemistry demonstrations
- outdoor fireworks at annual celebrations or at nightly theme-park displays

Potential future applications for our mixtures include
- low-smoke propellants in military rockets
- safe, noncorrosive propellants for deploying automobile air bags

**Benefits**

Our new, low-smoke pyrotechnic mixtures have a number of advantages over traditional pyrotechnic formulations. Our mixtures
- generate environmentally friendly, gaseous products: nitrogen, carbon dioxide, and water
- minimize the risk of respiratory illnesses because virtually no smoke or ash is produced
- greatly reduce the amount of metal salts needed to color the flame and thereby prevent dangerous levels of toxic metals from accumulating in the soil and groundwater
- increase safety during shipping because the fuel and oxidizer can be transported separately and mixed at the destination
- produce more intense colors in a wider variety of hues
- create comparable pyrotechnic effects with half of the material weight that has traditionally been used