

The Middle School Science of Liquid Crystal Mood Patches

By James C. Carpenter and Stephen D. Jacobs

Last November, Jori Semrau and 106 fellow sixth graders in four science classes at Arcadia Middle School, Greece, NY, carried out 1 hour experiments as part of their energy unit on heating and cooling. After being given a “private” lesson on making liquid crystal “mood patches”, Jori and four other student “instructors” helped their classmates to manufacture and test these novel temperature sensing devices. These students were the first in the nation to use a lesson devised by three undergraduate seniors at The University of Rochester: Katie Spencer (Optics '05), Rupal Varshneya (Optics '05), and Anne Marino (Mathematics '05).



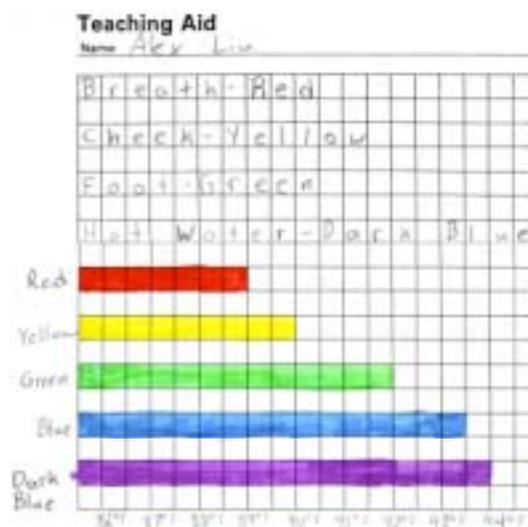
The connection between college students pursuing technical degrees and potential engineers of the future occurred as a result of joint OSA/SPIE initiatives in middle school outreach. Katie and her group worked up the mood patch lesson plan during the summer of '04, using a venerable paper by liquid crystal inventor James Ferguson¹ and chemicals donated by him. With additional support from the Rochester Section of OSA, an OSA National activity grant and a special SPIE educational grant, they prepared a prototype kit to do a class of 30 students and previewed it before several local teachers in September. After making some revisions, they produced 100 kits, complete with chemicals, substrates (black and clear squares of plastic transparency film), and a lesson plan explaining the basic properties of cholesteric liquid crystals and how the color of reflected light depends on temperature.



Andrea Nick Alison Kelly Nick

To advertise the kits, Katie and her team signed up to operate a booth at Educator's Day during the OSA Annual Meeting in Rochester on October 11th. For four hours they discussed the lesson and made mood patches for over 60 middle- and high school teachers from Monroe County and surrounding areas. Sixth grade science teacher Jim Carpenter was captivated by the color and dynamics of the lesson. After some e-mail correspondence with U of R's Steve Jacobs, they decided to move from “concept” to “classroom”. Sufficient additional supplies were sent to Greece Arcadia Middle School in November to enable Mr. Carpenter to give the lesson to all 4 of his classes.

Very little was done to revise the U of R student lesson plan. After a discussion of what liquid crystals were and how they worked, students made $\sim 1^{1/2}$ inch-square patches sealed with transparent wrapping tape. They quickly discovered that these sensors were useful for much more than assessing one's “mood”. Exposed sticky areas of the wrapping tape were perfect for placing the patches on hands, wrists, elbows, foreheads and feet. Inquisitive minds moved on to explore other items in the classroom, especially the cold outside windows. Through their experimentation with the liquid crystal mood patches the students found that these simple devices displayed various colors that directly related to surface temperatures. Each student developed his or her own bar graph (using calibration data supplied by Katie et al. in the lesson plan) to determine temperature ranges indicated by different colors.



Students found the lesson to be highly motivational. They returned over the next several days to ask if they could make more patches or to ask more questions: Are these materials used in liquid crystal displays? –ans: yes, suitably altered to reduce their temperature sensitivity and enhance their response to electric fields. Come next June, Mr. Carpenter expects this cool lesson to be the most memorable in his annual student poll.

Jim Carpenter (jcarpen1574@frontiernet.net) has taught middle school science for 27 years, 6 with Greece Arcadia Middle School, 130 Island Cottage Rd., Rochester, NY 14612. Steve Jacobs (sjac@lle.rochester.edu) is Senior Scientist in the Laboratory for Laser Energetics and Professor of Optics and Chemical Engineering at the University of Rochester. Jacobs is Education Committee Chair for the OSA Rochester Section and a Fellow of SPIE.

¹ J. L. Fergason, “Experiments with Cholesteric Liquid Crystals,” *Am. J. Phys.* **38**, pp. 425-428 (1970)