

Katie's Day at the Spa: The Chemistry of Nail Polish

by

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Katie's phone rang at 8 p.m. Friday evening. It was her sister Caroline. "Hi Katie, I'm picking you up at nine tomorrow morning and taking you to the spa."

"Caroline," replied Katie, "I can't spend the day at the spa. Who will watch Hailey?"

"Would you relax, Katie? I'll take Hailey for the day. I do have a little experience taking care of babies, ya know."

Eight-month-old Hailey was Katie's first and only child. After five years of graduate school, two post doctoral appointments and finally getting a career established at a major pharmaceutical company, Katie and her husband Jack decided to start a family. To their surprise, it took them three years to conceive. When Hailey came along, Katie felt unprepared and overwhelmed. She realized that she turned into a nervous, overprotective mom.

"I survived graduate school, didn't I? Why am I having so much trouble with motherhood?" Having to go back to work after her three month maternity leave didn't help.

"Katie, I can see how stressed out you've been lately," said Caroline. "When was the last time you did something for yourself? How long has it been since you even had a manicure?"

Before Hailey came along, Katie and her sister had a standing appointment every other Saturday morning for their "mani-pedi." Now, with the new responsibilities of motherhood, Katie just didn't seem to have the time. It had actually been almost a year since she had a manicure. She had to admit, it was a tempting offer, and Hailey did seem to enjoy being around her three older cousins.

"Ok," said Katie, "I'll take you up on your offer."

"Great!" replied Caroline. "See you at nine."

"Caroline" said Katie, "thanks for doing this."

The next morning Caroline dropped Katie off at the spa and told the receptionist, "Give her the works: mani-pedi, seaweed wrap, facial, massage, and aromatherapy bath."

"Did you want a regular manicure or shellac?" asked the receptionist.

"Shellac?" said Katie, puzzled by the question. "What's that?"

"OMG!" replied the receptionist. "Where have you been? We've been doing them for six months now! They are more expensive, but a shellac manicure will last you a month!"

"Wow," thought Katie, "a whole month? I'll definitely have shellac. Who knows when I'll be able to get back for another manicure?" With that, Katie kissed her sister goodbye. "Pick you up at four, Katie," said Caroline.

After painting each coat of nail polish on her nails, the technician put Katie's fingertips into a UV light box. After 30

seconds she pulled out her fingers and the tech wiped them with an organic solvent dampened cotton ball. Her nails were perfect and perfectly dry! Katie was really intrigued.

On the way home she asked her sister, “What is that shellac manicure about? How is it different from a regular manicure? How can it possibly last for a whole month?”

“How would I know?” replied Caroline. “You’re the organic chemist, you tell me.”

Katie thought she had a pretty good idea and the light box provided a major clue. When she got home, she started doing her homework. Katie found out it was a patented process. (The CND product called “Radical Solarnail” is protected by U.S. Patents 5,523,076, 6,818,207 and 8,124,058.) The chemistry was so simple. She had learned it in her sophomore organic chemistry class and she could kick herself for not thinking of this application herself. If she had, she could be sitting back and racking in the cash!



What did Katie find out? Use the following resources and your own research to answer the questions below.

- Drahl, C. 2008. Nail polish. *Chemical and Engineering News* 86(32):42.
<http://cen.acs.org/articles/86/i32/Nail-Polish.html>
- What is shellac nail polish? A perfect manicure in salon or at home. [Blog]
<http://manicuregirl.hubpages.com/hub/What-Is-Shellac-In-Salon-Or-At-Home-Perfect-Nail-Polish-Manicure>
- Level 4: Makin’ polymers. *The Macrogalleria: A Cyberwonderland of Polymer Fun!* [Website]
<http://pslc.ws/mactest/level4.htm>

Questions

1. What are the components of “regular” nail polish?
2. Read about cellulose in your textbook. What is the structure of cellulose and how does it relate to regular nail polish? How do you think the material used in standard nail polish is prepared? Show the reaction.
3. How does the derivatization of cellulose alter its physical properties?
4. Describe the production of Arnel® or acetate from cellulose derivatives. Show the reaction for the conversion of cellulose to Arnel and show the mechanism for this reaction. In what industry is Arnel extensively used?
5. What general class of reaction forms the shellac polish? Show the mechanism of this reaction. Label the steps initiation, propagation and termination.
6. Define monomers, oligomers and polymers. The nail polish itself is actually composed of a mixture of oligomers rather than just monomers. This helps the process of “curing” go faster. What is curing and why is it faster if oligomers are included?
7. What are the monomers that are used in shellac nail polish and why (In other words what properties of the molecules lend themselves to this application?)
8. The UV lamp is critical to this process. What is the purpose of the UV lamp? What is the purpose of the benzoyl peroxide? In what type of consumer product is benzoyl peroxide often used?
9. Why did the technician wipe the nail with an organic solvent dampened cotton ball? Why didn’t the technician just wipe the nail with water?

Presentation

Prepare a PowerPoint presentation for your classmates. Describe the background information and introduction to the questions asked by Katie. This should be followed by answers and explanation for each of the questions.

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