APPLICATION**NOTE**

Studying Curing Behavior of Nail Gels Using Rheology

Dr. Shona Marsh

Introduction

In the last few years, the nail polish industry has really opened up its beauty box of tricks and on the market today. To name but a few, we see nail polishes with "magnetic, gel, matte, glitter, crackle, stamping, quick-dry, caviar, sponge, colour changing, leather and sandy" effects. There are also nail polishes with kale, silk and nylon extracts! It really has turned into an art form.

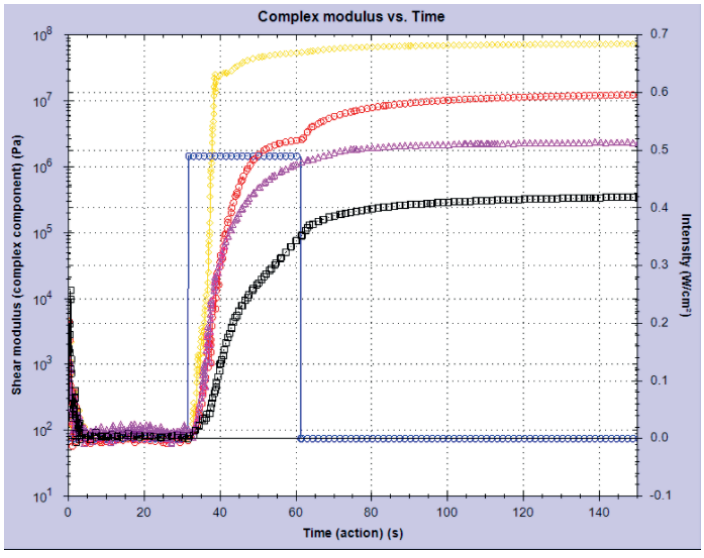
However, in order for us to appreciate the wonders of these magical nail polishes, surely there must be some exciting science behind it all? Many may have wondered and are fascinated by these different effects such as why "stamps", why crackle polish "crackles" and why UV nail polish "cures", etc.

Different Types of Gel Polishes Cure Differently

Believe it or not, there are varying degrees of curing gel polishes; those that are displayed in your local retailer as 'daylight curing' polish, those 'hybrid' gels that can be bought from your local shopping centre and then, of course, those 'soak-off' gels found only in your local beauty salon! Both the hybrid and soak-off gels require the use of a "UV lamp" to cure. The difference being that the hybrid gels incorporate similar solvents and additives as regular nail polish, allowing them to soak off faster and possess a lower viscosity for easier application. Traditional gels have a higher degree of cross-linking, resulting in a greater resistance to acetone [1].

How to Study Curing Behavior

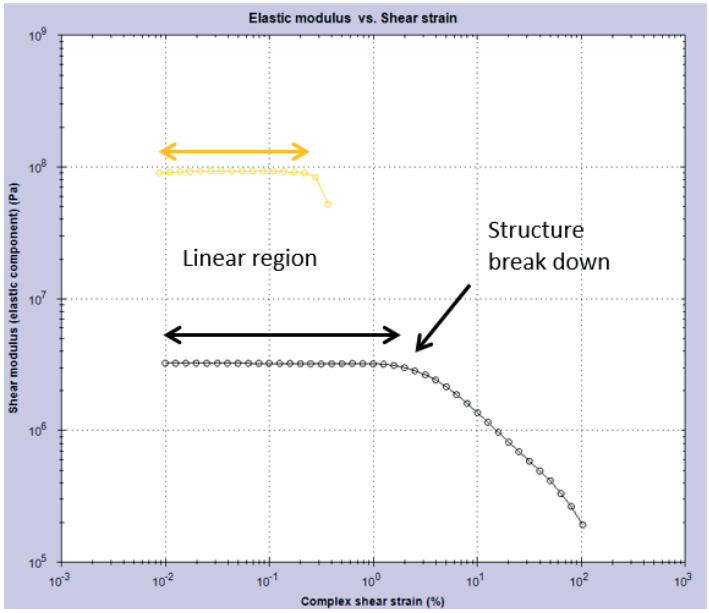
The Kinexus rheometer was used to study different colored UV-curing nail gels (of the soak-off variety) in the shades of gold glitter, red, pink and black. By applying a fixed intensity of UV light to the gels for 30 seconds, it is possible to monitor the curing profile and consequently the change in modulus (stiffness) in these materials over time. Distinct differences were seen between gels with different pigments (see figure 1). The clear gel with gold glitter particles cured the fastest of all four gels,



1 Curing profiles of different colored nail gels with time

NETZSCH-Gerätebau GmbH
Wittelsbacherstraße 42 · 95100 Selb · Germany
Phone: +49 9287/881-0 · Fax: +49 9287/881505
at@netzsch.com · www.netzsch.com

NETZSCH



2 Post-curing amplitude sweep of a gold glitter (yellow) and black gel (black)

exhibiting a much higher modulus (~7.5 · 10^7 Pa) in comparison to the black gel, which cured slower resulting in a much lower shear modulus (~3.7 · 10^5 Pa).

This result was confirmed by conducting a post-cure amplitude sweep on the gels. This measurement probed the linear visco-elastic region (LVER) of the samples by applying an increasing strain and determining the point at which the structure in the material was broken down – the onset of non-linearity. Figure 2 shows the results from this experiment and it can be clearly seen that the black gel has a longer LVER than the glitter gel.

Summary

Based on the results, it can be said that the black gel will be more flexible on the nail and is more likely to be easily removed. Due to the smaller (in strain magnitude) linear viscoelastic region, the glitter gel will exhibit more brittle properties and may also be harder to remove. It is instances like these where rheology can be employed as a useful tool in determining differences and characterizing products that will be noticeable and important to consumers.

This application note has focused on curing nail polish and the influence of pigments. However, the rheology of nail polishes builds up a picture of how the material behaves in use. Just like paints, nail polishes exhibit thixotropic properties – the properties that most importantly give you that nice smooth and even surface finish.

Sources

http://www.nailsmag.com/article/91808/the-science-of-gels?page=2

NGB · Application Note 215 · EN · 1121 · Technical specifications are subject to change.

NETZSCH-Gerätebau GmbH
Wittelsbacherstraße 42 · 95100 Selb · Germany
Phone: +49 9287/881-0 · Fax: +49 9287/881505
at@netzsch.com · www.netzsch.com