Now you see it, now you don't: An investigation of the composition of Pilot's FriXion range of erasable inks

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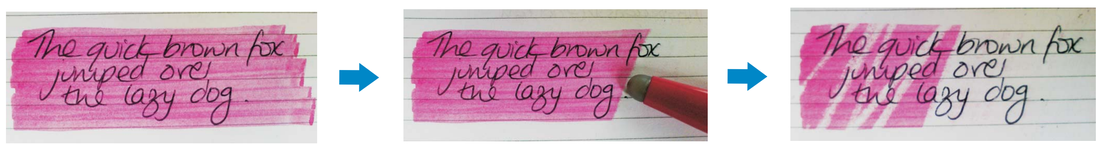
FriXion Pens

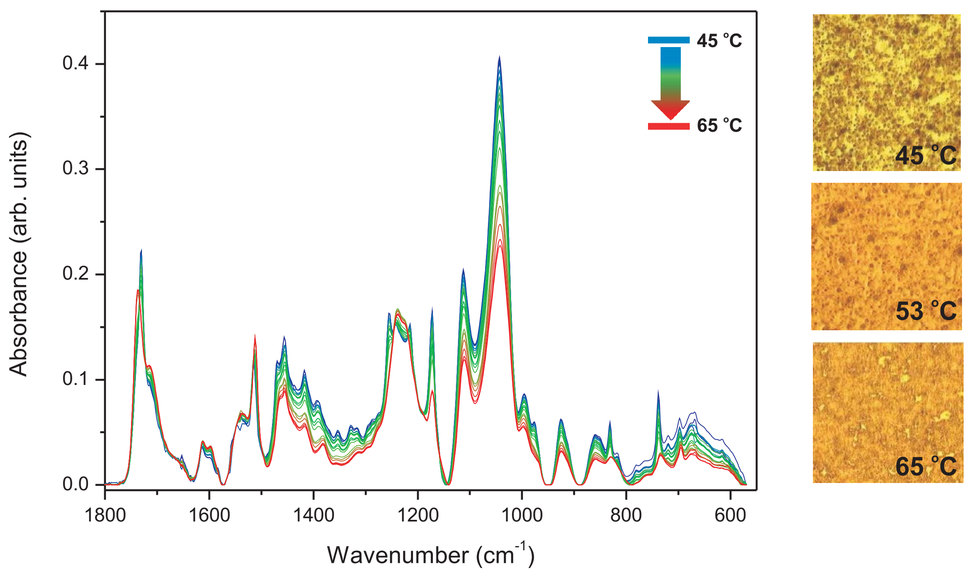
FriXion pens are a range of temperature sensitive ink based pens. They write like a normal pen but once placed on paper the ink can be made transparent by rubbing with the rubber tip of the pen. This creates heat, in the form of friction, causing the ink to change from coloured to colourless. The temperature sensitivity of the ink is reversable, but at much lower temperatures, meaning the 'rubbed out' ink must be below freezing for the colour to return.



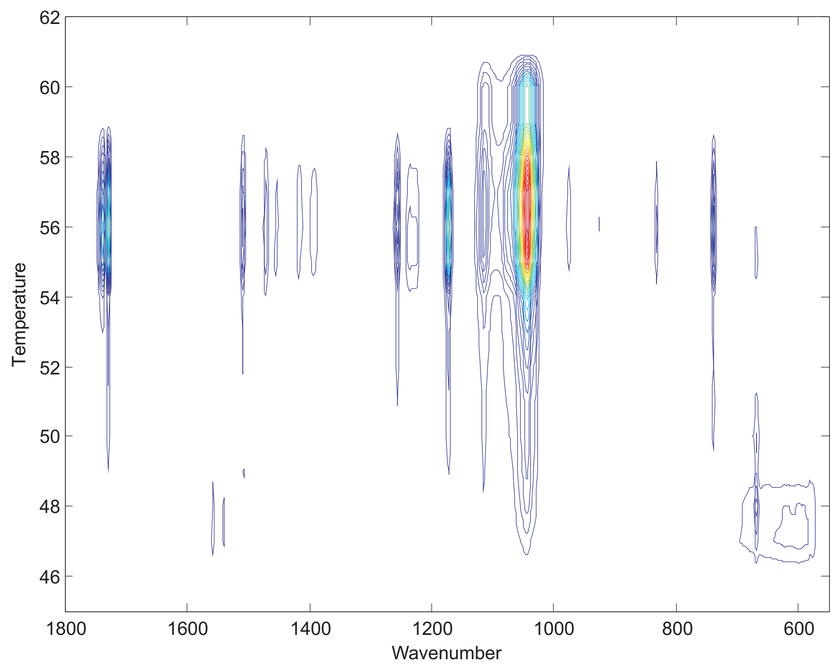
Sample Preparation

A layer of ink was placed on a round ZnSe slide and left to air dry. The ZnSe slide was then placed into a metal microscope slide holder, ensuring a direct connection between the ZnSe slide and the heated element of the holder, connected to a Bruker temperature control unit. Spectra were collected using a Bruker Hyperion 3000 IR microscope operating in transmission mode and using a x15 magnification objective. Background and spectra measurements were made at one degree intervals, for 32 scans. Spectra were recorded five minutes after each temperature adjustment to ensure the ink was at the correct temperature for measurement. Measurements were take for two different pens - one pink highlighter (shown in the example in the panel above) and one black gel ink ballpen.

Highlighter Ink



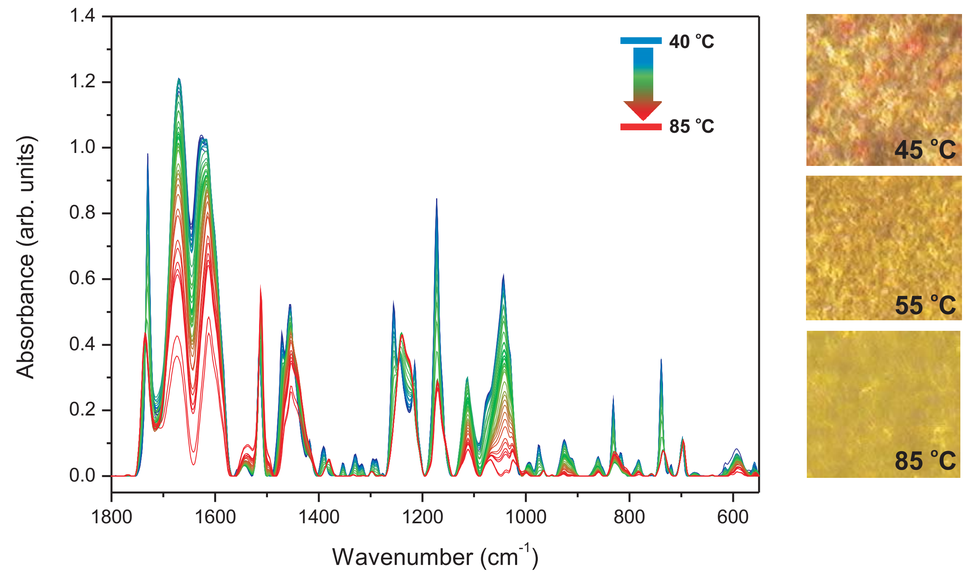
The figure above shows the IR spectra obtained for each temperature for the highlighter pen ink. The pictures on the right show the visible image of the ink obtained at 45, 53 and 65 °C.



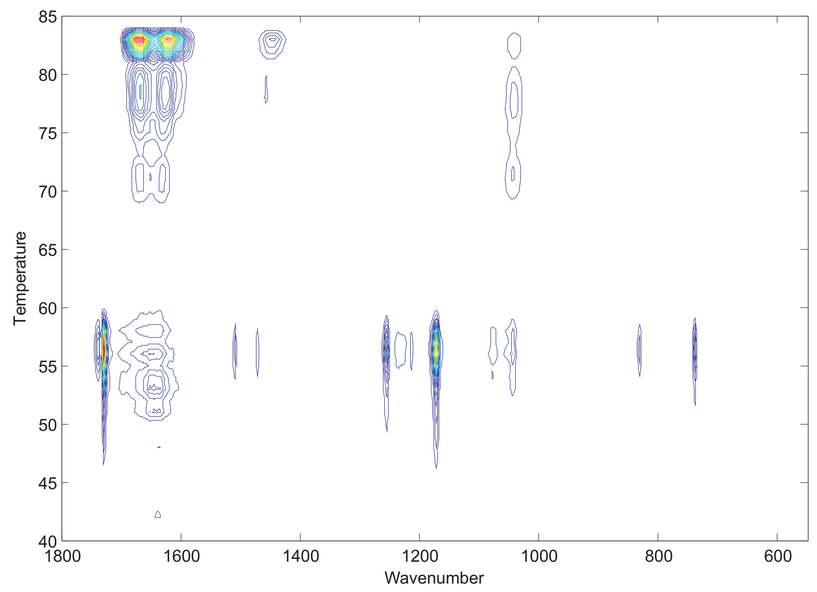
The figure above shows the 2D Correlation moving window plot of the temperature induced IR spectra shown at the top of this panel. The moving window analysis relates the spectral changes observed for the highlighter ink to the temperature at which these changes occur. (Moving window size was 5 spectra).

The moving window analysis of an extended temperature range to 85 °C was dominated by large intensity changes for the band at ~1043 cm^{-1}, dwarfing the changes centered around 60 °C, the temperature at which the ink is expected to change. Therefore, the following analysis has been restricted to a shorter temperature range. The temperature induced changes begin at approximately 47 °C with the most intense band in the spectrum, positioned at ~1043 cm^{-1}. The following intensity changes, for bands located at ~738, 1114, 1172 and 1729 cm^{-1}, occurs at approximately 49 °C. The final stage of intensity changes begins at approximatly 54 °C and involves a number of lower intensity bands. The majority of intensity changes stop at aproximatly 59 °C, with the exceptions being the bands at ~1043 and 1114 cm^{-1} where the intensity changes continue up to 61 °C.

Ballpen Ink



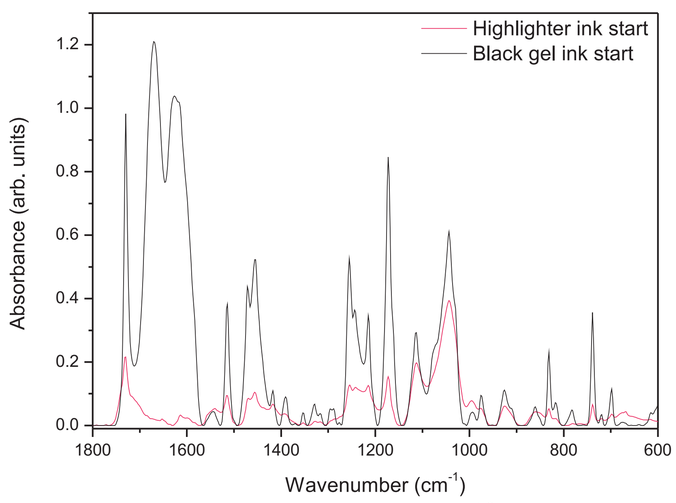
The figure above shows the IR spectra obtained for each temperature for the ballpen ink. The pictures on the right show the visible image of the ink obtained at 45, 55 and 85°C.



The figure above shows the 2D Correlation moving window plot of the temperature induced IR spectra shown at the top of this panel. (Moving window size was 5 spectra).

The moving window plot highlights two main regions of change, one between 45 and 60 °C and a second between 80 and 85 °C. (Restricting the moving window analysis to a smaller tempertaure range to remove the effect of the large intensity changes above 1600 cm^{-1} for high temperatures did not alter the profile of the remaining changes shown here). The region between 45 and 60 °C shows a similar profile to that of the highlighter ink. The initial changes, at 46 °C, are associated with the band at ~1043 cm^{-1}, followed by the band at ~1729 cm^{-1} changing at 47 °C. The subsequent changes affect the smaller intensity bands and begin at aproximately 54 °C. All temperature induced changes for this region finish by 60 °C.

Active Ingredients?



The figure to the left shows the spectra obtained for both inks at low temperature, before any of the temperature induced chances occur. The figure below shows the spectra obtained for the two inks at high temperatures, after the first group of temperature induced changes have occured.

The active ingredients contained in the FriXion pen inks are likely to be those common to both inks studied here.

Any suggestions as to what some or all of these components may be would be most welcome!