

## Forensic discrimination of blue pen inks: emergence of hybrid pen inks

### ABSTRACT

Pens are frequently used to make alterations to documents during forgery. Comparing to conventional inks, hybrid pen ink brings a different challenge to forensic document examiners in differentiating ink entries on a questioned document. Therefore, this study aims to investigate the characteristics of different blue pen inks using non-destructive approaches followed by destructive techniques. Twenty blue pens consisting of ten ballpoint pens and ten gel pens of various brands were subjected to microscopic examination, video spectral comparator examination, attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy, and thin layer chromatography (TLC) using two different solvent systems. The microscopic examination showed significant different optical features on handwritten samples produced by ballpoint and gel pens. Luminescence behaviour of certain inks allowed discrimination, and ATR-FTIR coupled with principal component analysis clustered ink samples of similar compositional profiles in a score plot. TLC allowed further discrimination of ink samples from ballpoint and hybrid pens. The proposed analysis scheme had categorised the ink samples into 11 groups. To conclude, the hybrid pen labelled as gel pen appeared optically like gel pen. However, it possesses chemical characteristics similar to a ballpoint pen. Therefore, its emergence deserves attention during forensic questioned document examination, particularly for the determination of pen inks.

**Keyword:** Forensic science; Questioned document; Ink; Hybrid pen; Discrimination; Alteration