Abstract

Four distinctive dental porcelain fused to metal (PFM) crown artefacts were received in connection with a forensic matter. It was suspected that these crowns had been immersed in hydrochloric acid for seven days. Previous analysis using scanning electron microscopy and EDS (Electron Dispersive Spectroscopy) had demonstrated that the items had been immersed in a corrosive substance, but could not determine specifically what the corrosive had been. Examination of the evidential crowns was then undertaken using XPS (X-Ray Photoelectron Spectroscopy) and it was demonstrated that the specific corrosive was indeed hydrochloric acid.

Materials and Methods

Previous investigation determined that the metal portion of the dental crowns comprised nickel, chromium, molybdenum and silicon as its major components, and that exposure to a corrosive agent had led to changes in the appearance of both the metal and porcelain components when viewed by a Scanning Electron microscope (SEM). SEM was not able to identify the specific corrosive agent used however.

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Results

The graph shown in Figure 6 shows the elemental composition of the crown at the location we scanned. It confirms the makeup of the crown as first determined by EDS. Crucially, it also shows the presence of chlorine.

To test the hypothesis that chlorine would be found only on the surface (indicating immersion in HCl), we used an in-situ Argon ion gun to etch 20 nanometres of the surface from the sample and then re-analysed the surface. The comparison between the two scans (before and after etch) is shown in Figure 7. The red line (prior to etch) shows the presence of the two peaks characteristic of Chlorine, confirming its presence on the surface layer, probably as the Chloride of Nickel, Molybdenum or both.

The post-etch (yellow line) shows a greatly reduced level of chlorine, confirming the hypothesis that the chlorine is confined to the surface level only.

Conclusion

The presence of Chlorine in the surface layer of the metal component of the dental crown, and the reduction in its level as we move more deeply into the metal, confirms the hypothesis that the corrosive substance in which this crown was immersed was Hydrochloric Acid (HCl).

Reference