Characterising Clothing Damage Caused By Acid Attacks

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Background

The use of acids as a weapon has sadly become commonplace in some regions around the world, including within casework in the UK, and prominent cases include that of Katie Piper in 2008[1]. As well as the damage to the body of the person attacked there will also be damage to their clothing, and potentially to the person throwing the corrosive substance. This project compared the damage seen in simulated attacks using different acids and different fabrics in order to determine if differences were observed, and provide the foundation for future work.

Key Results

- There is a visually distinguishable difference in the effects of different acids on fabrics.
- Some damage is not always visible until the fabric is put under tension (pulled).
- These differences are apparent even after washing and could aid with acid identification.

Methodology

Three acids were tested:
- Hydrochloric acid
- Sulfuric acid
- Nitric acid

Two fabrics were tested:
- T-shirts (100% cotton)
- Jeggings (61% cotton, 26% polyester, 12% viscose and 1% elastane – mixed material)

Both fabrics were black.

3mL of each acid was applied on to the fabric using a Pasteur pipette on to a demarcated 5cm^2 area of the fabric. A porcelain tile was kept under the area to avoid the absorption of acid into the other side of the clothing.

After the acid application initial damage and changes on the fabric were observed immediately (t=0 hour), and the fabric was then examined after 1 hour (t=1), 24 hours (t=24) and 48 hours (t=48). A subset of the clothing was washed after t=1.

Results – Acids on Cotton

The hydrochloric acid was found to be dry within 24 hours and visible patches of staining/damage were observed as shown in Figure 1. This staining/damage was only visible on one side of the fabric.

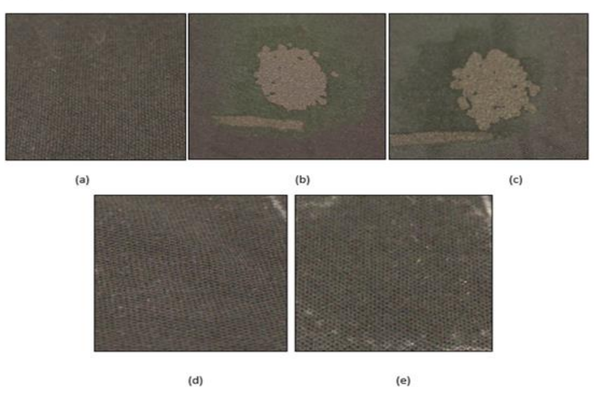

Figure 1. Cotton t-shirt with hydrochloric acid over the time period
(a) no acid added, (b) t=0, (c) t=1, (d) t=24 and (e) t=48

The hydrochloric acid was found to have spread beyond the original area of deposition which could have implications for assessing the volume applied and for safe handling of items of clothing.

Similar results were observed with nitric acid. With this acid spread it was also observed that there was weakening of fibres outside the original area. This resulted in tearing of the fabric when it was pulled at t=48 (shown in Figure 2). This fragility of the fabric is worth noting when handling this type of material.

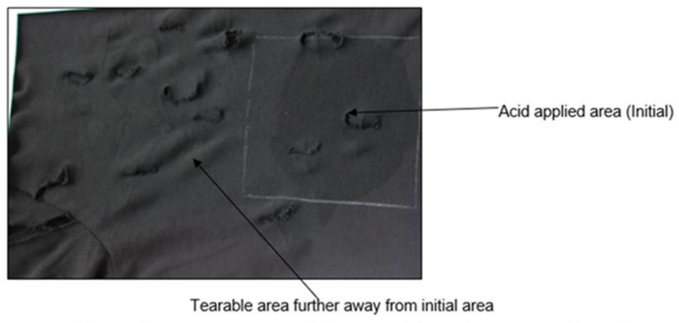

Figure 2. Areas of damage after pulling the cotton t-shirt (t=48) after application of nitric acid

Sulfuric acid was noted to behave slightly differently, and the acid was not dry within 24 hours. Some 'bubbling' of the acid was noted when it was applied to the fabric. The acid also caused a change of the fabric from black to a greenish colour (Figure 3) with damage also seen on the underside of the fabric on removal from the porcelain tile.

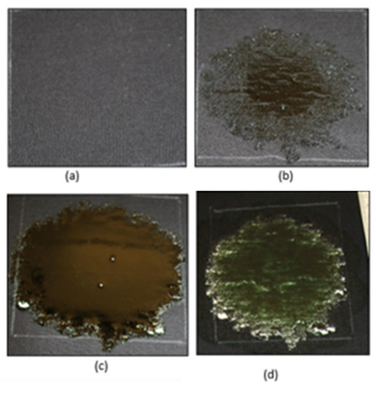

Figure 3. Cotton t-shirt with sulfuric acid over the time period
(a) no acid added, (b) t=0, (c) t=1, (d) t=24

Results – Acids on Mixed Material Fabric

Greater variation was seen with the mixed material jeggings, which could allow for potential visual identification of the acid responsible. Figures 4, 5 and 6 show the results seen for hydrochloric acid, nitric acid and sulfuric acid respectively.

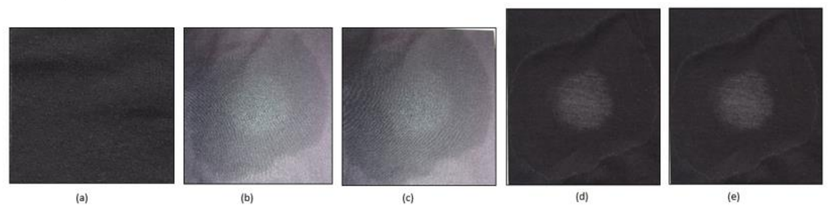

Figure 4. Mixed material jeggings with hydrochloric acid over the time period
(a) no acid added, (b) t=0, (c) t=1, (d) t=24 and (e) t=48

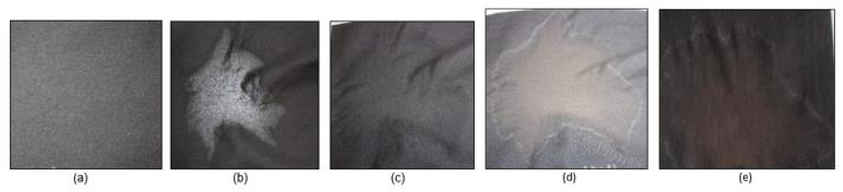

Figure 5. Mixed material jeggings with nitric acid over the time period
(a) no acid added, (b) t=0, (c) t=1, (d) t=24 and (e) t=48

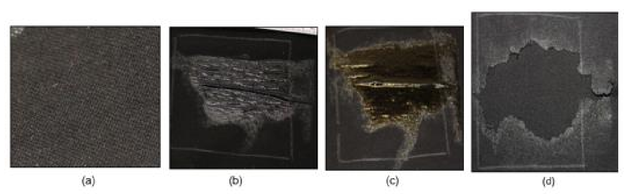

Figure 6. Mixed material jeggings with sulfuric acid over the time period
(a) no acid added, (b) t=0, (c) t=1, (d) t=24

Results – Effects of Washing

To simulate a perpetrator trying to remove the presence of acid staining, the effects of washing the fabric was examined. After a basic washing cycle with generic washing powder variation was seen across the different acids particularly when examining the mixed material jeggings.(Figure 7). While with hydrochloric acid there was no obvious staining or holes in the fabric, it was found that the fabric tore easily on pulling demonstrating a weakening of the fabric.

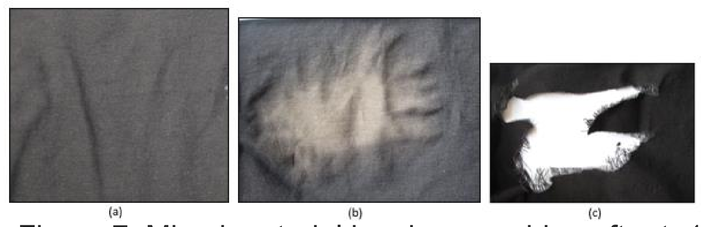

Figure 7. Mixed material jeggings washing after t=1
(a) Hydrochloric acid (b) Nitric acid (c) Sulfuric acid

Discussion & Conclusion

This proof-of-concept work demonstrated that there are distinguishable differences in the appearance of damage caused by acids on clothing. The acid and type of clothing appear to have an effect on the damage. This could have implications for investigation of the damage and identification of potential acids and perpetrators. Differences between acids were visible even after washing.

While the results of this work are promising, further work is needed to increase the usefulness to policing and forensic practitioners. This includes moving from laboratory grade acids to a wider range of corrosive substances obtainable by the general public, and increasing the range of materials and colours of the clothing tested. Additional work is needed to examine the effects of packaging the items and to determine if ion testing is the best method for chemical detection of corrosive substances.

A final consideration is whether the tear type damage could be mistaken for having been caused by a different weapon – initial observation of these results suggest that there are some characteristic differences but these should be further examined microscopically and with a wider range of weapons and clothing.

Acknowledgements

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Author Contact

If you are interested in more information on this project or the next steps that are being taken to move the project forward please contact Felicity.Carlysle-Davies@strath.ac.uk

References

1. https://katiepiperfoundation.org.uk/get-to-know-katie/ [accessed 10/5/22]