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Latent Damage in Keratin Fibres

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The investigation of archaeological keratin fibres by means of polarization microscopy shows a discrepancy in the results for the degree of damage when applied in non-swelling and swelling agents. On the basis of these observations, the concept of latent damage was developed. Latent damage is specified as an underlying but hidden damage in the protein framework, which cannot or only to a limited extent be assessed by non-destructive analytical tools (e.g. WAXS). This type of damage is located in the α-helical material of the intermediate filaments (IF).

Latent damage in archaeological keratin fibres

Using non-denaturing (polarising microscopy in glycerol, WAXS) and denaturing analysis tools (polarising microscopy in NaOH, DSC) show differences in the degree of structural damage of α-helical IF proteins. Protein denaturing methods as well as swelling agents can show a pronounced disturbance in the arrangement of the seemingly intact helical protein fragments for archaeological fibres.

Latent damage in bleached human hair

The underlying principles of latent damage were also applied to natural, recent hair for the case of multiple bleaching. WAXS only showed a moderate decrease in intact helical proteins at a very late stage of bleach repeats. By DSC for wet fibres a continuously increasing degree of damage of the IFs is observed with the number of bleaches.

Conclusion

When storing keratin fibres under environmental conditions with strong physical and chemical effects, strong bleaches or treating with Cu2+, both peptide bond breakage and oxidation and thus cleavage of cystine bonds occur. If these effects are largely confined to the dry state, bond breakages would not necessarily affect the arrangement of helical proteins in the IFs. Helical protein fragments would still appear structurally undisturbed. Accordingly, clear damage to helical structures, e.g., by peptide bond breakage is thus expected to be detectable with some common analytical methods only in cases of severe damage.

In case of denaturing analytical tools or under swelling conditions helical fragments are too small to contribute to the measured α-helical value. This damage of the hair fibre is referred to a ‘latent’.

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