Surface Reactions of Nitrogen Dioxide

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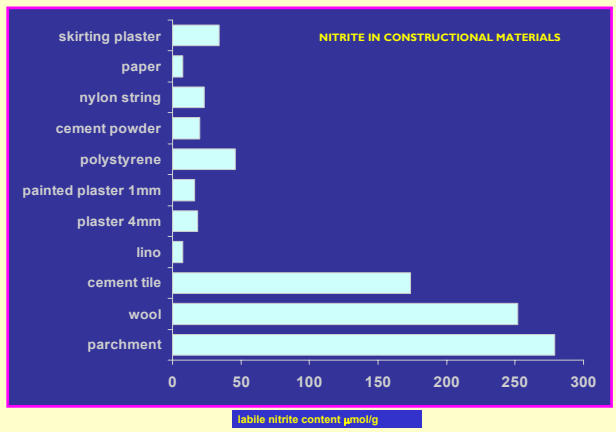
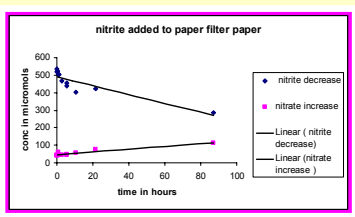
Nitrogen dioxide (NO_2) is cause for concern in museums because it has been associated with the degradation of dyes, fabrics and other organic materials.
Nitrogen dioxide is involved in a number of reactions in the indoor atmosphere, most particularly a rapid equilibration with ozone and nitric oxide (NO). Furthermore it appears to have a complex surface chemistry indoors where it generates nitrous acid (HONO) that is emitted by walls and leads to substantial indoor concentrations of this gas. If the room is bright, subsequent photochemistry can generate NO.
There is also the possibility that solid surfaces can release NO directly. We have been studying the surface reactions of deposited nitrogen dioxide to understand both the potential of indoor surfaces to release nitrogen containing gases and the way in which nitrogen oxides react and cause damage to items in the museum environment.

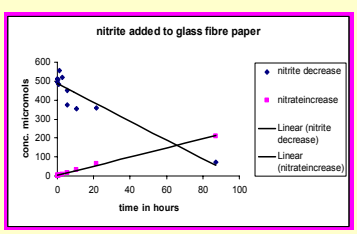
We have found that many typical indoor materials contain significant quantities of nitrite (NO_2^-).
Experimental evidence suggests that it originates through deposition from the air.
Understanding the chemistry that leads to this build up of nitrite in materials and the likelihood of re-emission as nitrogen containing gases, will enable us to determine the exact causes of damage to materials.

A cement tile analysed contained as much as 175 μg(NO_2^-) g^{-1}.
It was also found in wool (~20 μg(NO_2^-) g^{-1}) The nitrite in wool is released only slowly into the air but observations of indoor air composition suggest that it may well be emitted faster under damp conditions.
Very high concentrations (280 μg(NO_2^-) g^{-1}) are found in parchment, although that may be produced within the parchment itself.





We added nitrite solutions to filter papers and observed any changes.



We found:
- **As nitrite decreased nitrate increased and a gas was emitted.**
- **The surface structure affected the rate of reaction**
- **Enclosed surfaces slowed the reaction down**
- **The reaction is pH dependent**

Implications

Release of nitrous acid or nitric oxide may indicate a build up of nitric acid within the releasing surface. It is likely that damage attributed to nitrogen dioxide is actually due to nitric acid.