



PACE TECHNOLOGIES

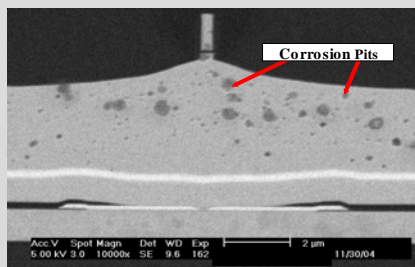
MAGNETIC HEAD (Corrosion Inhibitor Additives)

Corrosion Inhibitors

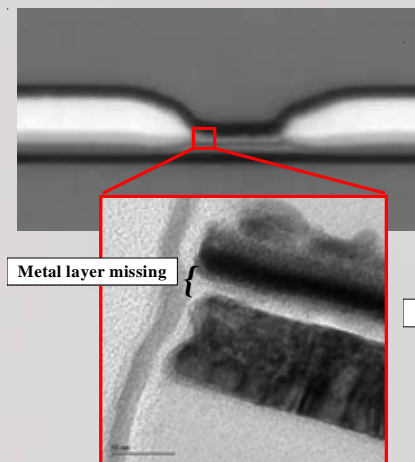
Corrosion inhibitors can be added to the present lapping lubricants, diamond abrasives, cleaning solutions and the D.I. water used for the manufacturing of GMR and TMR magnetic read-wirte devices. In particular, the corrosion rates of the more reactive metal

such as manganese can be reduced by over 90% with the addition of the corrosion inhibitor developed by PACE Technologies (patent pending).

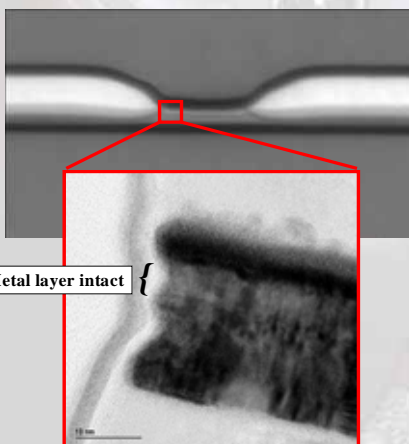
The type and number of metals and alloys being incorporated into the GMR/TMR stack offers a plethora of opportunities for galvanic and electrolytic corrosion for the magnetic hard drive and tape read-write heads. Galvanic corrosion occurs when two metals having different reduction potentials contact each other in an aqueous or semi-aqueous



SEM micrograph of Corrosion Pits in the Shared Pole (original magnification 10,000X)



TEM micrograph of a corroded slider



TEM micrograph of a good slider

Reduced corrosion rates with organic inhibitor

| | Corrosion rate without Inhibitor (Å/min) | Corrosion rate with Inhibitor (Å/min) | Corrosion Rate Reduction |
|----|--|---------------------------------------|--------------------------|
| Fe | 7.35 | 0.552 | 92% |
| Mn | 124 | 2.05 | 97% |
| Co | 4.42 | 0.132 | 96% |
| Cu | 1.76 | 0.015 | 99% |
| Ni | 1.33 | 0.020 | 99% |

PCC-5000
-Proplene glycol lube
-Additive for lapping lubricants

PCC-7500
-IPA base
-Additive for cleaning and rinse solutions

solution. The Table to the right shows the electrochemical potential for the metals used in the GMR or TMR stack at a metal ion activity or concentration of 10^{-6} M and a pH value of 5.7 (distilled water). The metals with a more negative reduction potential will corrode preferentially to the more noble or higher reduction potential metals when in contact with each other. Galvanic corrosion is also more prevalent as the reduction potential difference between the metals increases.

Organic Corrosion Inhibitor Additives

have been demonstrated to significantly reduce the corrosion of the GMR/TMR stack metals. The reduction in corrosion rate using the organic inhibitors specifically developed by Pace Technologies, shows that the corrosion rate can be reduced by >90%.

Inhibitors Additives

PG Based Corrosion Inhibitor – This additive is added to existing lapping lubricants. It is also recommended that the lapping lubricants be used in conjunction with this additive in order to improve the lapping cut rate.

Reduction Potentials in Distilled Water

| Electrode Reaction | Reduction Potential (V) @ 10^{-6} M / pH 5.7 |
|---|--|
| $ZrO_2 + 4H^+ + 2e^- = Zr + 2H_2O$ | -2.10 |
| $Mn(+2) + 2e^- = Mn$ | -1.36 |
| $RuO_2 + 4H^+ + 4e^- = Ru + 2H_2O$ | -1.14 |
| $Ta_2O_5 + 10H^+ + 10e^- = 2Ta + 5H_2O$ | -1.05 |
| $Cr(+3) + 3e^- = Cr$ | -0.858 |
| $Fe(+2) + 2e^- = Fe$ | -0.617 |
| $Co(+2) + 2e^- = Co$ | -0.457 |
| $Ni(+2) + 2e^- = Ni$ | -0.427 |
| $Ir_2O_3 + 3H_2O + 6e^- = 2Ir + 6OH^-$ | -0.390 |
| $Cu(+2) + 2e^- = Cu$ | 0.163 |
| $Au(+1) + e^- = Au$ | 1.34 |

More reactive metals (corrode first) ↑

Potentially can corrode in D.I. water (pH 5.7)
 Forms a non-passive oxide coating

IPA Based Corrosion Inhibitor – This concentrated additive can be added to most cleaning solutions and especially the distilled water rinse. This inhibitor has been shown to significantly reduce the optical corrosion of the writer head.

| Anti-corrosion additives | | |
|--------------------------|------------------|--|
| Inhibitor | Base | Application |
| PCC-5000 | Propylene glycol | This additive is added to existing lapping lubricants. It is also recommended that the lapping lubricant and diamond slurries use this additive in order to improve the lapping cut rate. |
| PCC-7500 | IPA | This concentrated additive can be added to most cleaning solutions and especially the distilled water rinse. This inhibitor has been shown to significantly reduce the optical corrosion of the writer head. |