Applying Co-Sputtering to Increase DDR During Deposition of Titanium Oxides and Silicon Oxides

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Problems of vacuum coatings technology

- Quality
- Productivity
- Cost
How reach increase of technology productivity?

- Increase in specific power of sputtering (w/m).
- Work in a transition mode with control on a feedback.
- Increase in sputtering factor by consecutive co-sputtering.
<table>
<thead>
<tr>
<th>Material</th>
<th>DDR, co-sputtering</th>
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<tbody>
<tr>
<td>$\text{Al}_2\text{O}_3$</td>
<td>+80%</td>
</tr>
<tr>
<td>$\text{TiO}_2$</td>
<td>+100%</td>
</tr>
<tr>
<td>C</td>
<td>+280%</td>
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<tr>
<td>$\text{SiO}_2$</td>
<td>??</td>
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</tbody>
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Data from Fraunhofer institute publications
Serial co-sputtering diagram

Parameters
- Main magnetron – Si or Ti
- Auxiliary magnetron – W
- Pressure – 5 mtor
- Distance target-drum – 100 mm
- Rotary magnetron length – 0.66 m
- Auxiliary magnetron length – 0.47 m
- Power supply – pulse DC
- Power (main) – up to 10 kW
- Power (aux) – 0-3 kW
- Substrate speed – 0.2 – 5 m/min
Reactive process scheme

Gas flows - Q

Q(Ar) → MFC
Q(O₂) → MFC
Q_leak

Vacuum chamber - p

p(Ar) = \frac{Q(Ar)}{S(Ar)}
Q*(O₂) → Reaction → Q*(des.r)
Q*_{leak} r

Pumping - S

Q(Ar)
Q_p(O₂)
Q_{des. p}
Q_{leak p}
Comparison of process characteristics and properties of SiO$_2$ coatings at sputtering power of 7.5 kW/m and 12 kW/m (planar magnetron, pulse power supply).
SiO$_2$ and TiO$_2$ light transmission spectrums

a) SiO$_2$, $n_{\text{sio}2} = 1.48$
   $n_{\text{PET}} = 1.65$

b) TiO$_2$, $n_{\text{sio}2} = 2.35$
   $n_{\text{PET}} = 1.65$

Transmission spectrum of silicon oxide (a) and titanium oxide (b) coatings of varying thickness produced applying serial co-sputtering
Comparison of process characteristics and properties of SiO$_2$ coatings at sputtering power of 12 kW/m and 15 kW/m in a serial co-sputtering process (pulse power supply.
Tungsten influence on properties of silicon oxide.
The scheme of reflection of cascades of collisions

Summary

• Specific power of sputtering, sputtering mode, sputtering factor - the major factors defining DDR.
• Co-sputtering of silicon and tungsten allowed effectively increase DDR for SiO$_2$ coating (+75%).
• In reactive processes it is recommended to use magnetron pulse power supplies.
Thanks for your attention.
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