METALLISATION FUNDAMENTALS

A technical primer for new engineers in flexible packaging

1. WHAT IS METALLISATION?

Metallisation is the process of depositing a very thin metal layer (typically 20-40 nanometres) onto a plastic film substrate such as PET, BOPP, or CPP. This is done in a vacuum chamber where metal wire is heated and vaporised, then condensed onto the moving film. The result is a shiny, reflective film with excellent barrier properties against oxygen, moisture, light, and aroma.

2. THE PROCESS IN 5 STEPS

1. **Film Loading** — Bare plastic film loaded on unwinder inside vacuum chamber
2. **Vacuum Creation** — Chamber pumped to <8×10■■ mbar using diffusion + rotary pumps
3. **Wire Feeding** — Solid aluminium wire fed continuously into ceramic evaporation boats
4. **Evaporation** — Boats heated to 1400-1600°C; aluminium melts then vaporises upward
5. **Condensation** — Al vapour deposits on the chilled drum where film runs (drum at -15 to -20°C)

3. KEY PROCESS PARAMETERS

PARAMETER	TYPICAL RANGE	WHY IT MATTERS
Chamber Vacuum	< 8×10■■ mbar	Lower vacuum = contamination in layer
Drum Temperature	-15 to -20°C	Colder drum = denser Al layer
Line Speed	650-800 m/min	Higher speed = thinner Al layer
Boat Current	700-900 Amps	Controls evaporation rate
Optical Density (OD)	2.0 - 2.8	Measures Al layer thickness
Al Layer Thickness	20-40 nanometres	The working barrier layer

THE BARRIER MIRACLE OF 40 NANOMETRES

At 40nm, aluminium blocks 99.9% of oxygen, moisture, and light.
Silver and gold cannot do better at this thickness — that's physics, not chemistry.

4. WHY ALUMINIUM IS THE UNIVERSAL CHOICE

Aluminium dominates industrial metallisation for one simple reason: it is the only metal that scores well on ALL seven critical properties simultaneously.

✓ **Cost-effective**	~■380/kg — affordable for mass packaging
✓ **Low evaporation point**	2,470°C — workable with ceramic boats
✓ **Good adhesion**	Bonds well to PET, BOPP, CPP substrates
✓ **Food-safe (GRAS)**	Approved globally for food contact
✓ **Excellent barrier**	99.9% opaque to light, oxygen, moisture at 40nm
✓ **Chemically stable**	No reaction with food acids, oils
✓ **Infinitely recyclable**	95% energy saving vs. virgin production

5. WHEN TO CONSIDER ALTERNATIVES

Transparent barrier needed →	Aluminium Oxide (AlOx) or Silicon Oxide (SiOx)
Antimicrobial packaging →	Silver (natural antibacterial property)
Premium aesthetic / luxury →	Gold (chocolate, perfume, cosmetics)
Non-food decorative →	Copper (rose-gold colour, gift wrap)
RFID shielding films →	Copper (electrical conductivity)
Corrosion protection →	Zinc (sacrificial anode property)

6. COMMON ENGINEER QUESTIONS

Q: Why 40nm and not thicker?
A: Beyond 40nm, barrier quality plateaus. Thicker wastes aluminium + makes film brittle.

Q: Is metallised film the same as aluminium foil?
A: No. Foil is 9-20 micrometres thick (500× thicker). Metallised is vapour-deposited nano-layer.

Q: Does aluminium contact food directly?
A: No. Structure: outer print layer + aluminium + inner sealant (PE/PP). Sealant touches food.

Q: What is double metallisation?
A: Two Al layers deposited for ultra-low pinhole count. Used for pharma and long-shelf-life.

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