Oxidation of aluminium

Aluminium oxidises very readily but this is advantageous as the aluminium oxide is tougher than the aluminium metal as so the oxide protects the metal. The aluminium oxide is also less dense than the metal and so takes up more space than the metal and so as the metal is oxidised it puts the aluminium oxide in compression and this helps provide the surface with a good barrier layer that reduces the rate of any further oxidation.

Thus the first monolayer of oxidation is virtually instantaneous dependent only on the arrival rate of oxygen. Beyond this the oxidation rate is dependent upon both the oxygen arrival rate and the rate of diffusion through the existing oxide layer. Typically the oxide could be expected to be 1.5nm – 2nm almost immediately and 2nm – 4.5nm in anywhere from 1 month to 1 year dependent upon conditions.

In most metallizers the residual gas within the vacuum system, even where the system can reach a good base pressure, means that the rate of arrival of oxygen to any surface is faster than 1 monolayer per second. Hence there is always plenty of oxygen available to oxidise the aluminium surface even in a vacuum system. It is also worth bearing in mind that even at the high aluminium deposition rates available in modern aluminium metallizers it is still common for there to be 1% - 2% oxygen contained within the coatings.

Where oxygen is not available as a gas the aluminium is happy to strip the oxygen out of water molecules and as water is the dominant background gas of all vacuum systems there is no shortage of oxygen for oxidation to occur.