Laser nitriding is known to be an effective method to improve the surface hardness and wear resistance of titanium and its alloys. However, the process requires a gas chamber and this greatly limits the practicability for treating orthopaedic implants which involve complex-shaped parts or curved surfaces, such as the tapered surface in a femoral stem or the ball-shaped surface in a femoral head. To tackle this problem, a direct laser nitriding process in open atmosphere was performed on commercially pure titanium (grade 2, TiG2) and Ti6Al4V alloy (grade 5, TiG5) using a continuous-wave (CW) fibre laser. The effects of varying process parameters, for instance laser power and nitrogen pressure on the surface quality, namely discoloration were quantified using ImageJ analysis. The optimised process parameters to produce the gold-coloured nitride surfaces were also identified: 40 W (laser power), 25 mm/s (scanning speed), 1.5 mm (standoff distance) and 5 bar (N2 pressure). Particularly, N2 pressure at 5 bar was found to be the threshold above which significant discoloration will occur. The surface morphology, composition, microstructure, micro-hardness, and tribological properties, particularly hydrodynamic size distribution of wear debris, were carefully characterized and compared. The experimental results showed that TiG2 and TiG5 reacted differently with the laser radiation at 1.06 μm wavelength in laser nitriding evidenced by substantial differences in the microstructure, and surface colour and morphology. Furthermore, both friction and wear properties were strongly affected by the hardness and microstructure of titanium samples and direct laser nitriding led to substantial improvements in their wear resistant properties. Between the two types of titanium samples, bare TiG2 showed higher friction forces and wear rates, but this trend was reversed after laser nitriding treatments.