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Collection of Abstracts of the 24th Materials Engineering Colloquium in Chemnitz

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Achieving multi-directional Directed Energy Deposition with Plasma Arc Welding, using Surface-Scan-based Bead Shape Fits for 3D path planning

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Abstract. Plasma arc welding is well suited to the directed energy deposition (DED) of titanium alloys. The multi-directional layer build-up enabled by industrial 6-axis robots circumvents the necessity for support structures, thereby increasing material utilisation and reducing the requisite machining effort. Pure object manipulation is employed to maintain a flat welding position independent of the build-up direction. A unified monitoring and control system for the DED was developed within the "Robot Operating System". This system uses sensor data to iteratively define path planning settings and welding parameters.For thin-walled parts with closed contours, a weld end parameter set was developed to ensure continuous deposition with consistent weld geometry in overlapping beads. The suitability of such a weld parameter setting is demonstrated on a 100-layer hollow cylinder. The acquired laser profile scan data indicated a circular weld bead surface cross-section. To determine the point of rotation for multi-directional layering, a circle was fitted to the bead surface cross-section. Rotation around the centre of this fitted circle enabled the successful multi-directional production of a nozzle shaped geometry with increasing tilt angles. Stable deposition of tilted layers was achieved by reduction of current and nozzle-to-work distance. Adjusting the welding parameters shifted the material transfer mode from intermittent to continuous. A material deposition stabilising effect of the surface tension between the wire and the melt was observed. The proposed bead-surface-based path planning approach can be applied to DED with other welding processes as well as different weld bead geometries.