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Effect of process parameters on the surface roughness of aluminum alloy AA 6061-T6 sheets in frictional stir incremental forming

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ABSTRACT

Incremental Sheet Forming (ISF) is characterized by essential flexibility, great formability, and low forming forces and cost compared to the conventional sheet metal forming processes. ISF was born as an advance sheet metal forming process to perfectly fit previous requirements. Nevertheless, growing demand to apply the lightweight materials in several fields was placed this developed process in a critical challenge to manufacture the materials with unsatisfied formability especially at room temperature. Thus, utilizing the heat at warm and hot condition in some ISF processes has been introduced to solve this problem. Among all heat-assisted ISF processes, frictional stir-assisted Single Point Incremental Forming (SPIF) was presented to deal with these materials. In this work, this emerging process was utilized to manufacturing products from AA6061-T6 aluminum alloy. Experimental tests were performed to study the influence of main parameters like tool rotation speed, feed rate, step size and tool size on the surface roughness of the produced parts. A Taguchi method and varying wall angle conical frustum (VWACF) test were used in the present work. The results find that tool diameter has a significant impact on the internal surface roughness produced via the forming process with a percentage contribution of 93.86 %. The minimum value of the surface roughness was 0.3 μm.

ARTICLE INFO

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Friction stir forming;
Incremental sheet forming (ISF);
Heat-assisted ISF;
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Izvirni znanstveni članek

Vpliv procesnih parametrov na površinsko hrapavost pločevine iz aluminijeve zlitine AA 6061-T6 pri vodenem tornem inkrementalnem preoblikovanju

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POVZETEK

Za inkrementalno preoblikovanje pločevine (ISF) je značilna prilagodljivost, velika sposobnost preoblikovanja ter nizke preoblikovalne sile in stroški v primerjavi s konvencionalnimi postopki preoblikovanja pločevine. ISF se je pojavil kot napredni postopek preoblikovanja pločevine z namenom popolnoma zadostiti obstoječim zahtevam. Naraščajoče povpraševanje po lahkih materialih je postavilo razvoj procesa pred kritičen izziv, saj se je na mnogih področjih pojavila zahteva po izdelkih iz materialov z nezadovoljivo sposobnostjo preoblikovanja, zlasti pri sobni temperaturi. Zato je bila za reševanje tega problema pri nekaterih procesih ISF vpeljana uporaba toplote za preoblikovanje pri toplih in vročih pogojih. Za obravnavo takšnih materialov je bil, med vsemi s toploto podprtimi procesi ISF, izbran proces vodenega točkovnega tornega inkrementalnega preoblikovanja (SPIF). V članku je predstavljena uporaba tega nastajajočega procesa za proizvodnjo izdelkov iz aluminijeve zlitine AA6061-T6. Izvedeni so bili eksperimentalni testi za preučevanje vpliva glavnih parametrov, kot so vrtilna hitrost orodja, hitrost podajanja, velikost korakov in velikost orodja na površinsko hrapavost izdelkov. V članku smo opisali teste izvedene po Taguchi metodi, na odrezanem stožcu s spremenljivo koničnostjo. Rezultati kažejo, da ima premer orodja pomemben vpliv na hrapavost notranje površine, ki nastane s postopkom preoblikovanja, s prispevkom 93,86 %. Najmanjša vrednost površinske hrapavosti je bila 0,3 μm.

PODATKI O ČLANKU

Ključne besede:
Vodeno torno preoblikovanje;
Inkrementalno preoblikovanje;
Toplotno podprto inkrementalno preoblikovanje;
Površinska hrapavost;
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