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Research paper

Effect of Friction Stir Welding Speed on Mixed the Stir Rings of Dissimilar Aluminum Alloys (2024-6061)

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Abstract

The research aims to study the speed effect of friction stir welding tool on the process ofinterference between tow Aluminum alloy (2024-6061) and its effect on the microstructure. A group of pieces from both alloy were taken and welded by means of friction stir welding (FSW) with application of different speeds of rotation . The specimen is then tested using photo microscope. The test showed that two region containing onion rings or (loops) as a result of diversity of the tow alloy and formation of these loops in more than one place in the welding region .The high speed of rotation will result in an incomplete defragmented loops but softer than the case low speed and the process of mixing and friction will raise the surface temperature which will cause Grain Growth in the bonding region of two alloy especially at high speed of rotation .

Keywords: *Stainless steel, weldment*

1. Introduction

The Friction stir welding (FSW) is a new and important process which used in automatic aircraft industries. And solving a lot of welding problems in high quality project [1]. This type of welding invented actin 1991 at the welding institute (TWI) . Firstly used in welding of aluminum alloys like (2000, and 6000), which shows a brittle and dendritic problem through fusion welding [2]. Now proceeding to another alloys such as magnesium alloys, titanium alloys, copper alloys, steels and stainless steels [3-5] .

The temperature that created at this process (FSW), it's always low than melting point of welded metal, while its upper the recapitalization (more than 0.4 Tm in K) .this process produced small grain size at stir zone [6] and precipitation process [7-8] . The friction process goes to producing heat, which important for welding. And also the vertical pressure due to process itself will insist to increases temperature. By speed of tool revolution dome rated by stir process [9-10]. In this work the effect of revolution speed will of study on the bonding mechanism and its effect of microstructure of dissimilar alloys.

2. Experimental work:

Two types of aluminum alloy [2024 and 6061] were used in this work, the chemical analysis is explained in table (1) [11]. Specimens were prepared by using hydraulic cutter. The samples polished from the two sides from the thickness which before that retargeted by using milling machine as in figure (1) . The welding stir tool was prepared by using turning machine as in figure (2) . The welding process was accomplished by using a fixture used for this perpous to weld the weldment which prepared for the dissimilar joint of 2024 alloy to 6061 alloy . After welding finished, the welded joint were cutted by using samples cutter for microstructure testing at technology and science ministry by using microscope type Nikor Eclipsf ME600 connected to a special computer .

Table 1: chemical composition of aluminum alloy (2024 – 6061)

	Percentage of Alloying Element									
	Ag	Cr	Cu	Fe	Mg	Mn	Ni	Si	Zn	Zr
2024	---	---	4.5	0.3	1.5	0.6	---	0.3	---	---
6061	---	0.2	0.3	---	1.0	---	---	0.6	---	

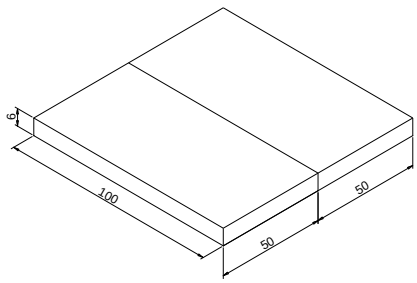


Fig 1: dimensions of specimen

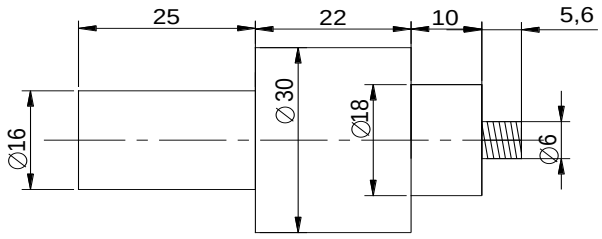


Fig 2: dimensions of welding stir tool

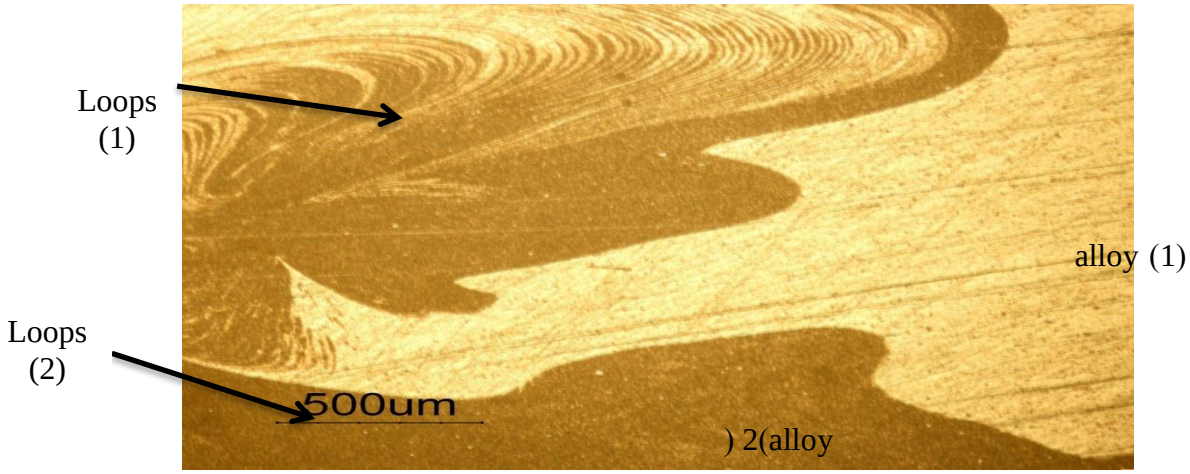
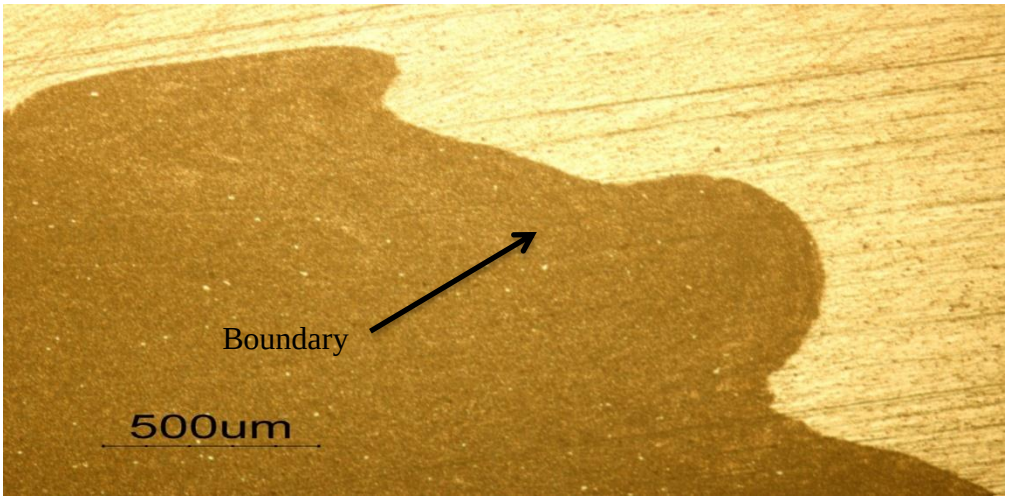


Figure (3) shows inference between (2024-6061) and Onion Rings at 50X and 585r.p.m



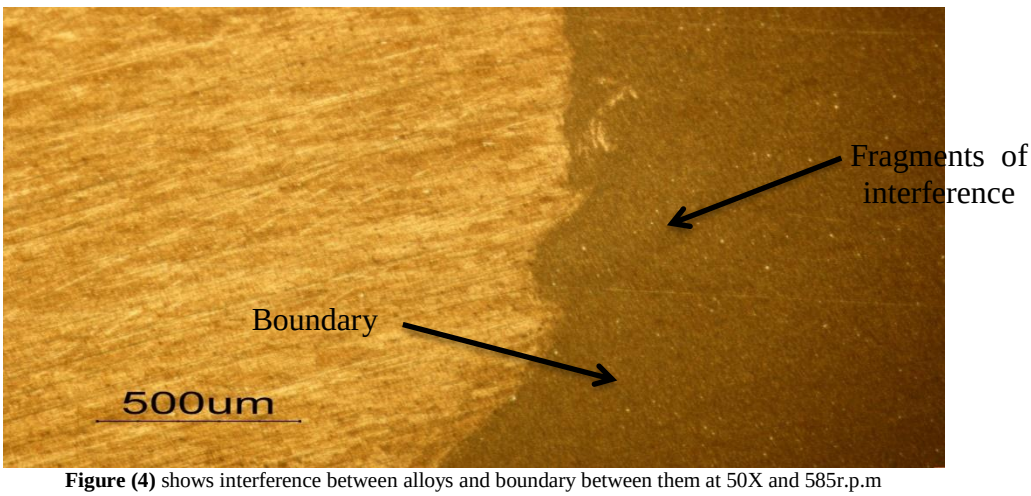


Figure (4) shows interference between alloys and boundary between them at 50X and 585r.p.m

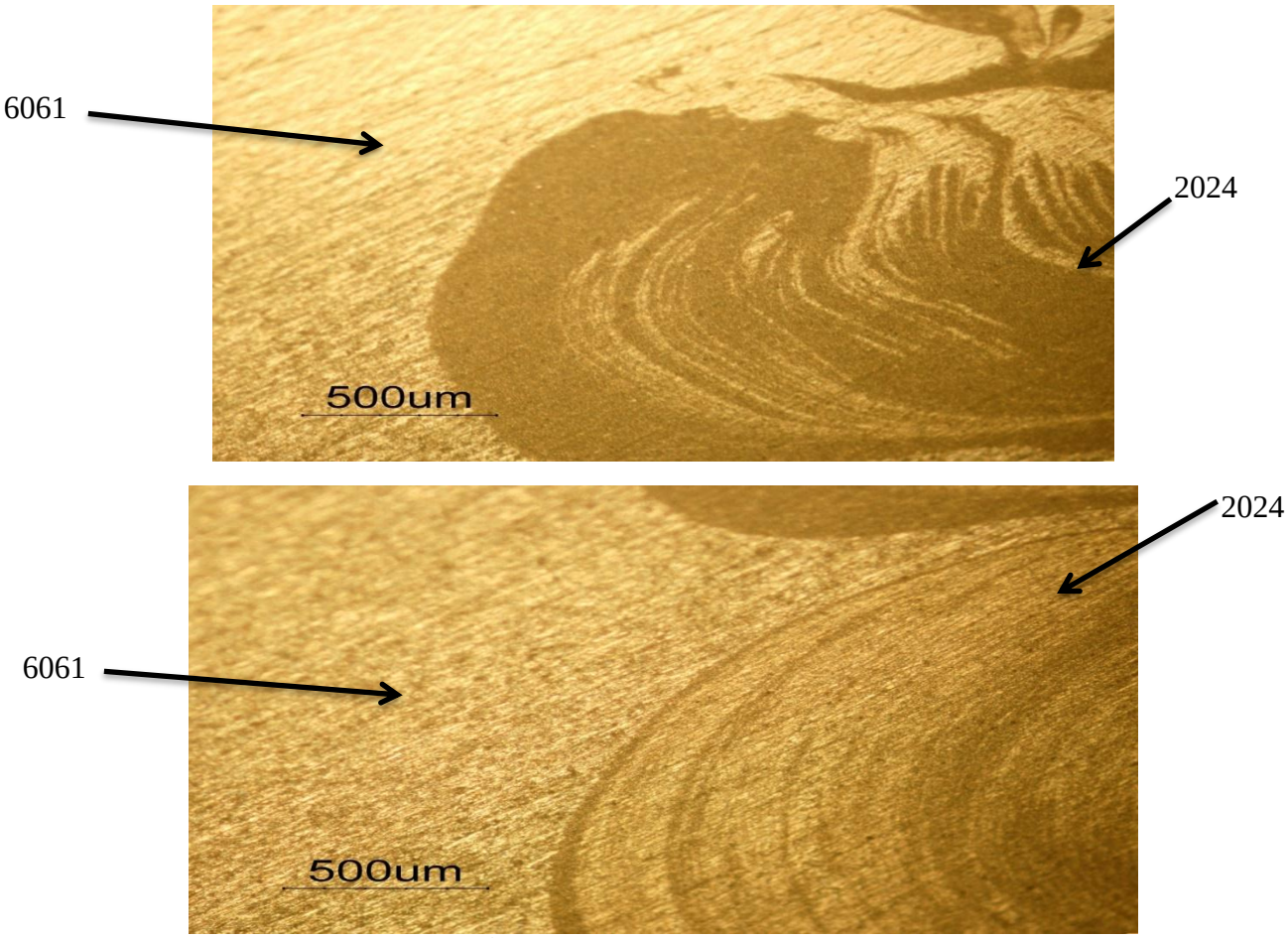
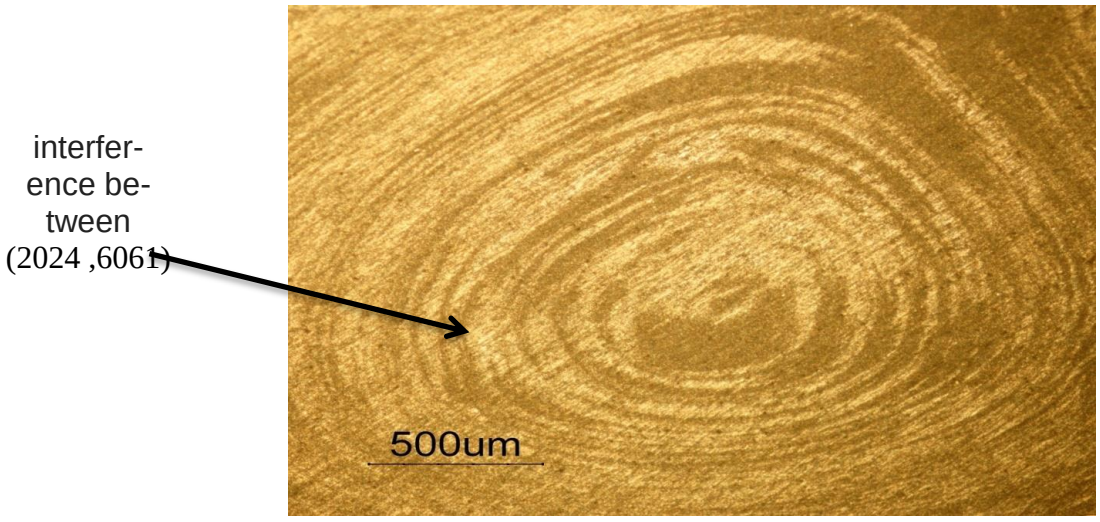
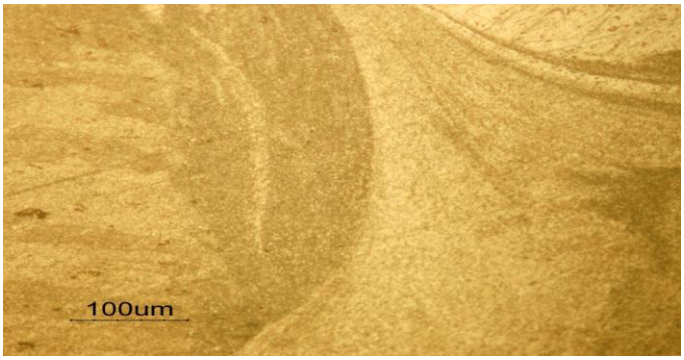


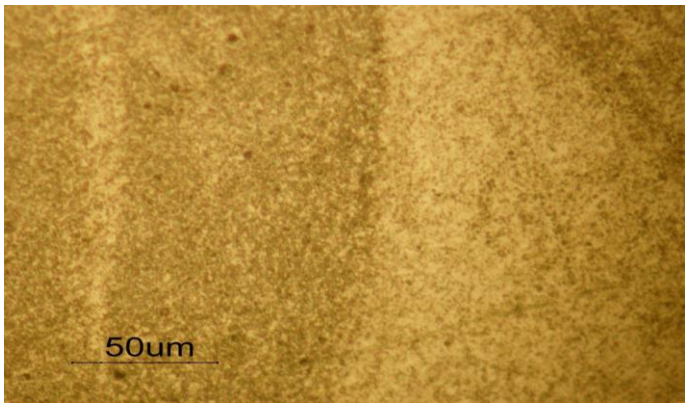
Figure (5) shows the interference chips and they are more than one place at 50X and 585r.p.m



Figure(6) shows Onion Rings in boundary region at 50X and 585r.p.m



(a)



b)(

Figure (7) shows the microstructure of the welding region of the two alloys (2024-6061) at (a) 200X, (b) 500X and 585r.p.m

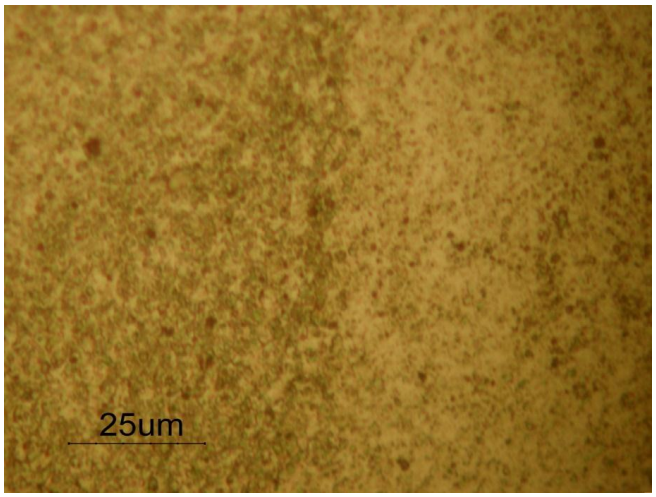
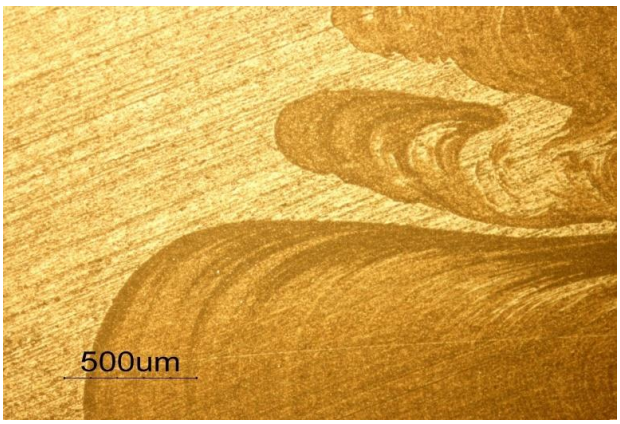


Figure (8) shows the microstructure of the interference zone between the two alloys at1000X and 585r.p.m



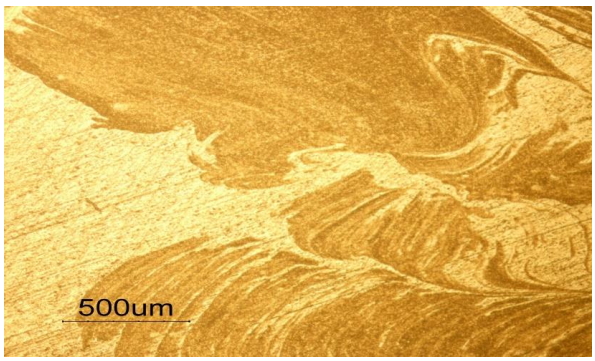
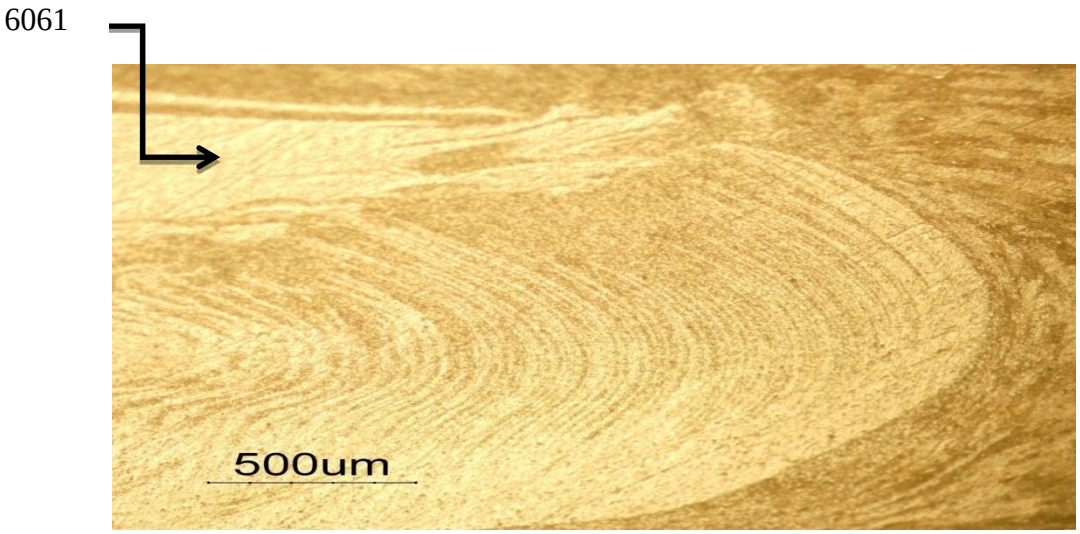


Figure (9) shows the interference region at high speed and incomplete chips at 50X and 1050 r.p.m



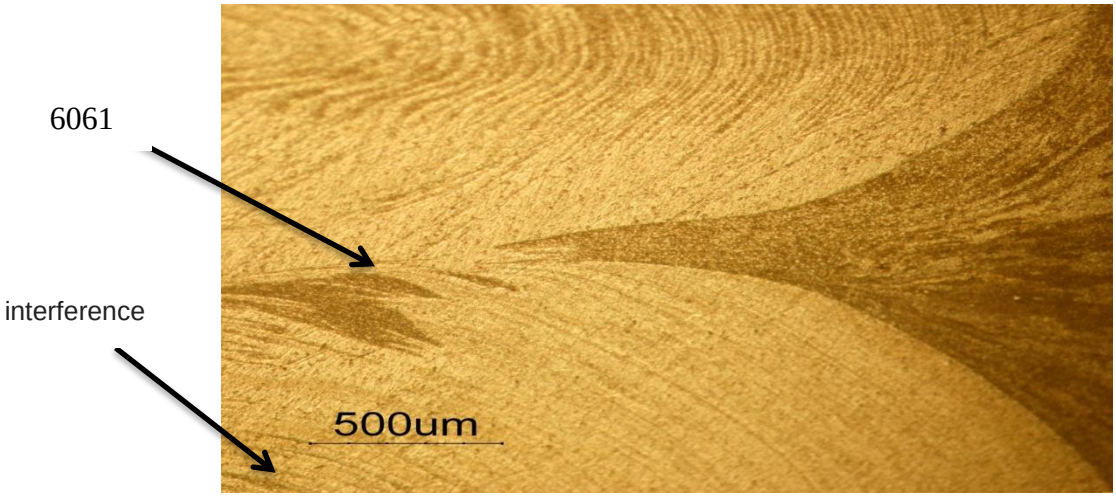
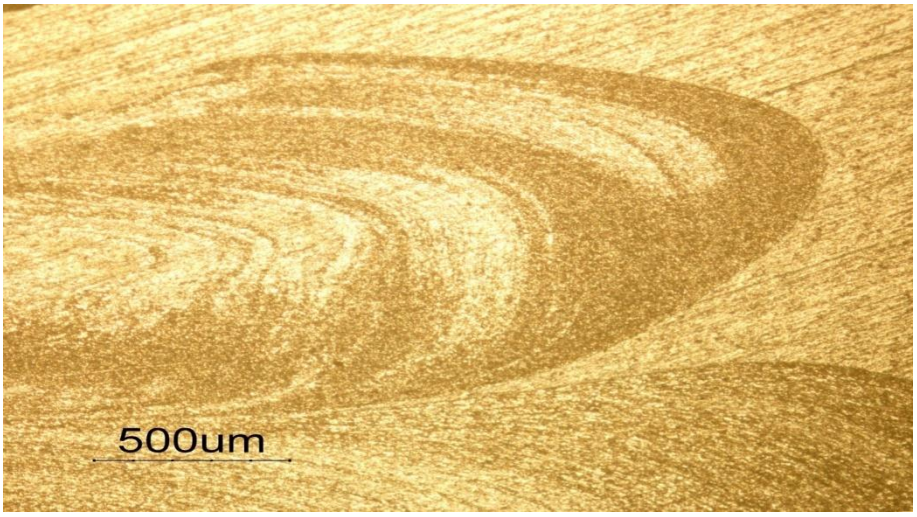


Figure (10) shows the interference chips in the welding area at a high rotation speed at 50X and 1050 r.p.m



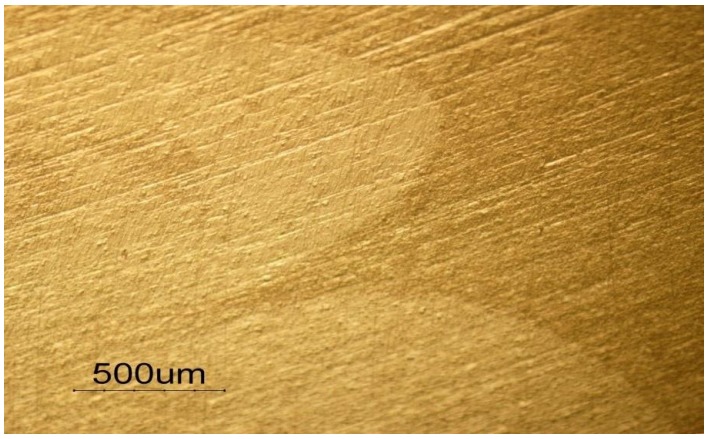


Figure (11) shows that it is not possible to produce complete rings at a high rotation speed at 50X and 1050 r.p.m

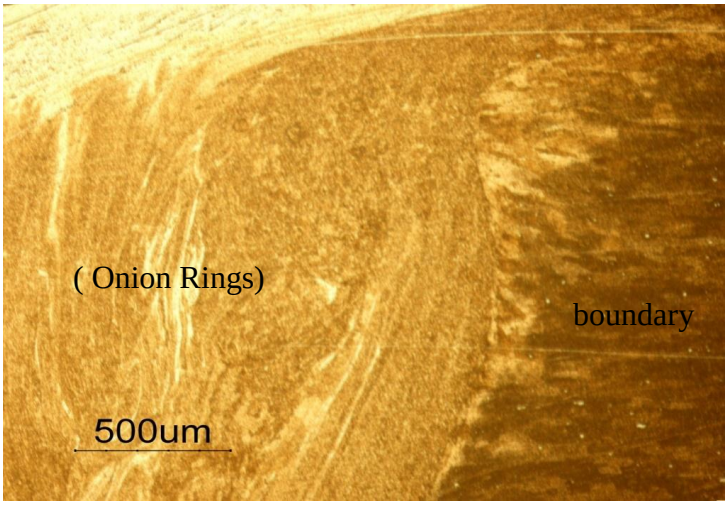
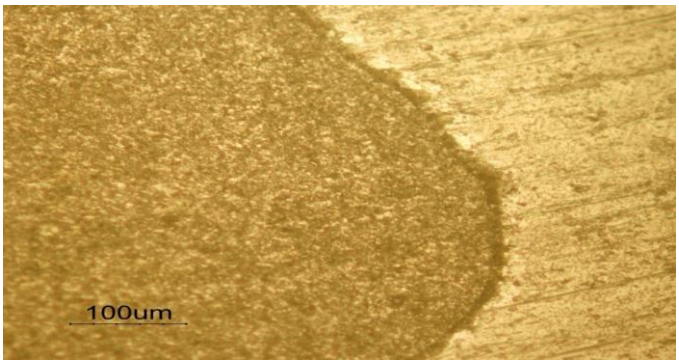


Figure (12) Shows the process of formation of the Onion Rings at 50X and 1050 r.p.m



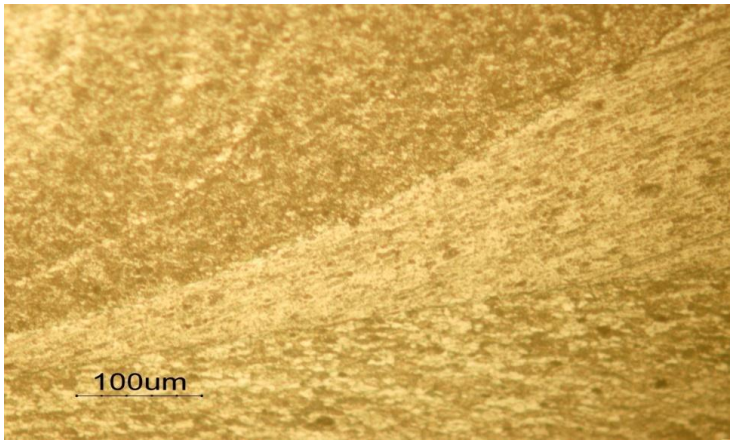
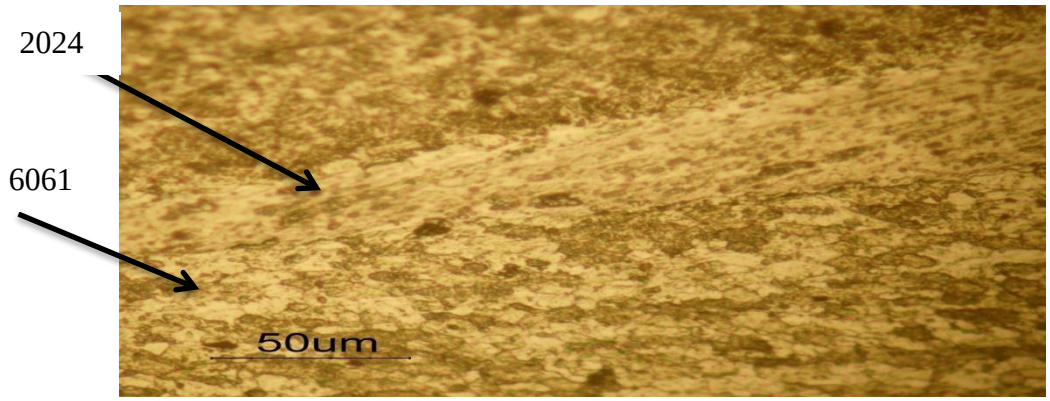
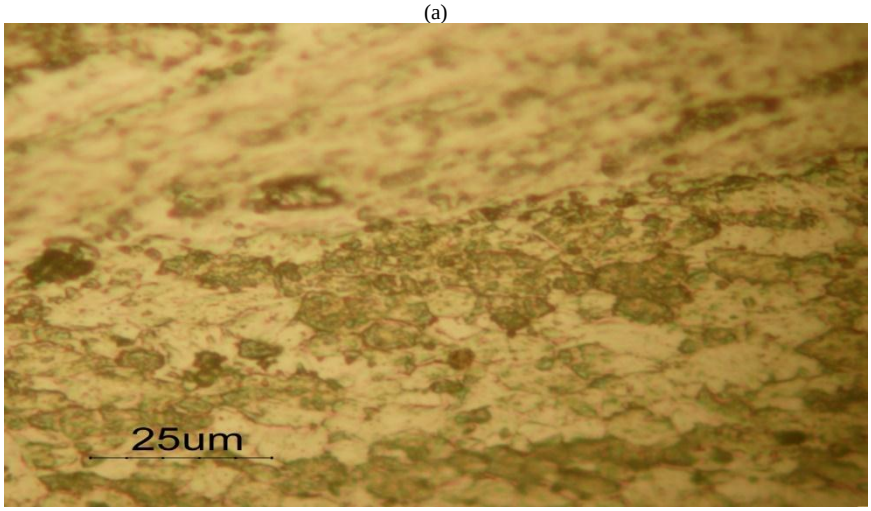


Figure (13) shows bending and curvature at the boundary between the two alloys at 200X and 1050 r.p.m



(a)



(b)

Figure (14) shows the recrystallization and grain growth of the two alloys at (a)(500X),(b)100X and 1050 r.p.m

3. Results Discussion

The important points that should be pointed when welding a dissimilar alloys like (2024 to 6061) is how that materials interaction through the process to complete joining process.
Figure (3) shows this interaction , which showing the onion rings this type of structure is an evidence for this interaction as in the process of different water density interaction in ocean . Figure (4) the interaction process and the interface line by 585 r.p.m speed. The waves appear at the interface one of the important eve dance for the interaction theory .The process showing fragments at this interface when dissimilar alloy be welded. Figure (5) showing more detail about the above phenomenon. Figure (6) shows these closed layers in one effected zone at the interface, which it's a property of this type of welding . Figure (7) also represent this type of welding which lead to good welding properties.
Figure (8) explain the onion rings but with some of fragment because of the increasing of welding revolution speed as in figure (9) and (10) which they shown the softness of this creation which may lead to increase the strength of joints. Figure (11) documented the phenomenon in previous figures .While figure (12) point out that the existence of this rings behind the interface. Figure (13) explain that the wavement of the interface due this process. Figure (14) showing the grain growth due to temperature increasing which may reach more than (210°) which is the recrystallization temperature.

4. Conclusions

1- The existence of onion rings because of the interaction between the dissimilar alloys.
2- The low welding speed lead to create closed onion rings than the high speed which lead to fragments of this rings .
3- The softness of rings by using high welding speed lead to increase the strength of weldments.

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