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Investigation of Flexure Strength of Aluminum Composites Reinforced with Iron Fibers

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بحث متانة الانثناء لمتراكب الالمنيوم المدعم بالياف الحديد

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Abstract:
Flexure strength of Aluminum composite reinforced with iron fiber has been investigated.Atomization procsses method were used to prepare sheet of aluminum reinforced with iron fiber with direction (0-90°) and (0-45°) to cognition fiber direction effect on flecture strength values.The results shows that the values of maximum bending stress, yield stress and young modulus of aluminum reiforced with iron fibers direction (0-90) higher than for the aluminum reinforced with fibers direction (0-45). The optical microscopy and photographic pictures shown the fracture surface of the tested specimens and fibers segmented and supported the rising in the flecture strength values of the aluminum composites(0-90).

الخلاصة
تم بحث متانة الانثناء لمتراكب الالمنيوم المدعم بالياف الحديد.استخدمت طريقة القولبة بالترذيذ لتحضير صفائح من متراكب الالمنيوم المدعم بالياف الحديد ذات اتجاه(٠-٩٠) و(٠-٤٥) لمعرفة تاثير اتجاه الليف على قيم متانة الانثناء . اظهرت النتائج ان قيم اعظم اجهاد ثني ، اجهاد الخضوع ومعامل المرونة للالمنيوم المدعم بالياف الحديد ذات الاتجاه (٠-٩٠) اعلى منها لمتراكب الالمنيوم المدعم بالالياف ذات الاتجاه (٠-٤٥). اظهرت صور المجهر الضوئي والفوتوغرافية سطح الكسر للنماذج المختبره وتقطع الالياف مما دعم ارتفاع قيم متانة الانثناء لمتراكبات الالمنيوم(٠-٩٠).

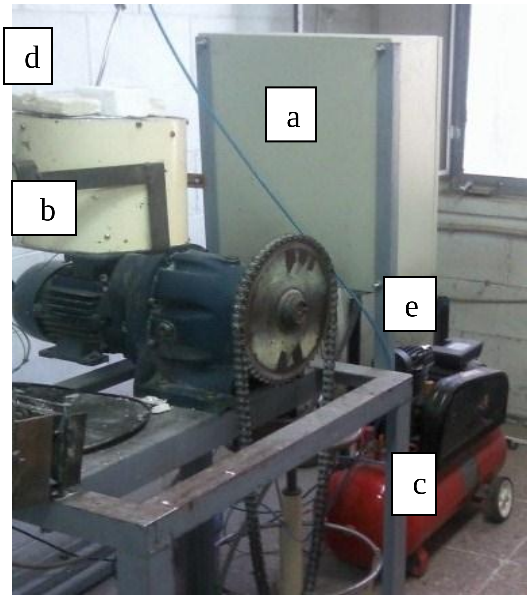
Introduction
Metal composite materials have many application in areas of daily life for quite some time .The reinforcement of metals have many different objectives. The reinforcement of light metals opens up the possibility of application of these materials in areas where weight reduction has first priority. The precondition here is the improvement of the component properties. . Metal matrix composite materials can be produced by many different techniques. The

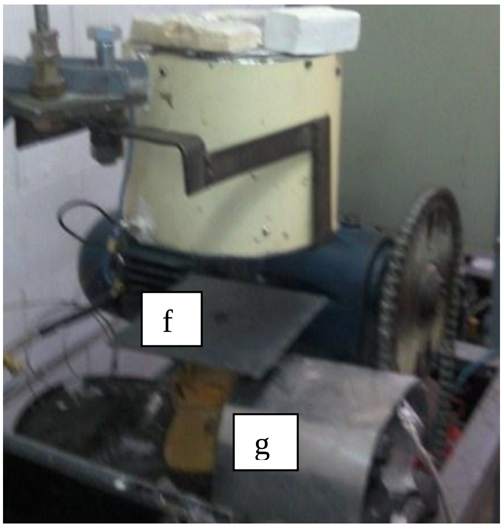
focus of the selection of suitable process engineering is the desired kind, quantity and distribution of the reinforcement components (particles and fibers), the matrix alloy and the application(1). The metal matrix composites, can exhibit unique properties if compared with traditional materials as well as potential for new applications. They were designed with the aim to conjugate the desired characteristics of two or more materials, constitute one of the most important research fields in materials science and engineering(2) . Metal matrix composites (MMCs) consist of a metal or metallic alloy matrix reinforced by whiskers, particulates, filaments, or wires of another material(3-4). The advantages of MMCs over monolithic metals are higher specific strength (strength-to-density ratio) and specific stiffness (stiffness-to-density ratio), improved fatigue and wear resistance, better mechanical properties at elevated temperatures, and tailor able coefficients of thermal expansion. Compared to polymer matrix composites (PMCs), MMCs have better fire resistance and high-temperature properties, greater transverse stiffness and strength, no moisture absorption or outgassing, higher electrical and thermal conductivities, and higher radiation resistance(5-6). Aluminum is one of the most important structural metals employed in engineering design. By itself in a pure form, aluminum is quite malleable and rather weak. However, aluminum is most often used as an alloy, where the addition of alloying elements creates a material that is both lightweight and can have incredible strength(7-8). Pure aluminum is soft, ductile, corrosion resistant and has a high electrical conductivity. It is widely used for foil and conductor cables, but alloying with other elements is necessary to provide the higher strengths needed for other applications. Aluminum is one of the lightest engineering metals, having a strength to weight ratio superior to steel .By utilizing various combinations of its advantageous properties such as strength, lightness, corrosion resistance, recyclability and formability, aluminum is being employed in an ever-increasing number of applications. A*luminum matrix composites* (AMCs) have been widely studied since the 1920s and are now used in sporting goods, electronic packaging, armours and automotive industries. They offer a large variety of mechanical properties depending on the chemical composition of the Al-matrix (9-10-11). The physical and mechanical properties of MMCs are sensitive not only to the type of reinforcement but to the mode of preparation and the details of any preparation processing of the composite material after initial manufacturing**.** In this investigation atomization techniques has been used. Atomization is the preferred method for producing rapidly solidified powders or other products of metals, alloys and composite. These products have outstanding or special properties which cannot be obtained by conventional processing routes**.** The benefits of rapidly solidified products of metal, alloys and composites are a result of the higher cooling rates achieved in the process. In atomizing process, molten metal, alloys, or composite passes through a nozzle manufactured from suitable material (refractory, alloy, metal) in the bottom of the tundish , crucible, or furnace. Atomization of molten stream by the atomizing gas, typically air, occurs at the point of exit from the nozzle. The resulting spray of molten metal droplets then impinges on a collector substrate to produce a dense deposit or perform. The atomization process depends on many parameters such as melting temperature, droplet size , droplet velocity , metal flow rate , gas flow rate and flight distance (12).

Experimental part

Aluminum rods and Iron fiber supplied from Iraqi market were used to industrialization metal matrix composites using spray casting method (atomization).

The atomization apparatus consists of five basic units that can be listed as follows; a)Air pressure unit, b)Nozzle unit ,c) Melting unit ,d) Control unit ,e) furnace





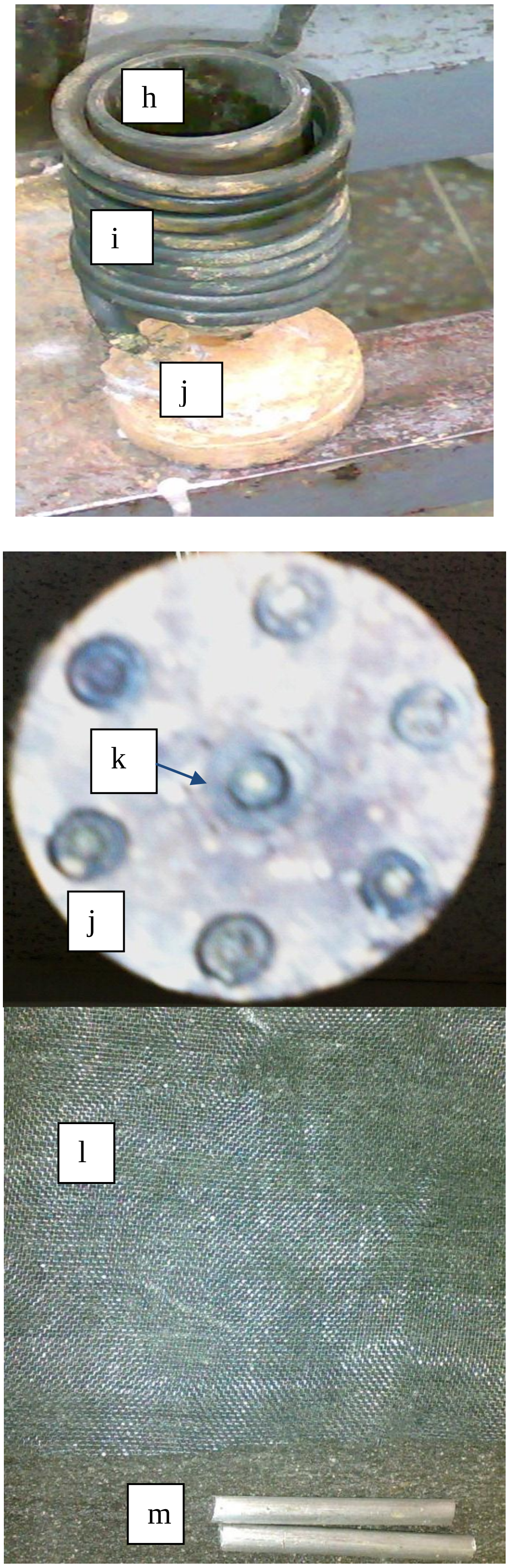


Fig.(1):a)Control; b)Furnace; c)Air compressure ;d)Air pressure; e) Pressure indicator; f) Rotating substrate ; g) Motor; h) Molten feeding ;i)Air flow ;j)Chamber ;k) Nozzle slot ;l) Irion fibers; m) Aluminum rods

Aluminum Composites preparation

Sheet were prepared using atomization system where aluminum in the form of rods was melted in an electrical resistance furnace at temperature about (660°C) then atomized with air pressure (7 bare) on a rotating substrate contains an iron fiber tightly fixed on a plate with direction(0-90°) and with (0-45°) direction for the second prepering processing. The atomization was carried out on two stages at first the front face of the molds was atomized then themolds were turned down to atomize to get aluminum reinforced with iron fibers as shown in figure (2).

Fig.(2): Sheet of aluminum composite.

Bending test

A sufficient number of specimens were cut out of the molds the dimension of the samples were cut accordance with the related international, ASTM standard 1184D.Two group of samples were cut from the molds the mold reiforced with fiber direction (0-90°) ,the second mold reinforced with fiber direction(0-45°) .

Results and Discussions

The unique properties of the fiber reinforced composite materials are to a great extent dependent on the unique nature on the matrix-fiber interface which can be defined as the region of significantly changed chemical composition constituting the bond between the matrix and the reinforcement for transfer of loads between these members of the composite structure(13). In bending test the specimen effects by two mode of test. The convex side of the specimen is extended and the concave side is compressed with an unstrained neutral axis through the center . Results of bending test for specimens which is reinforced with iron fiber with direction (0-90°) shown in figure (3). At low flexure stress, the bending stress proportion linear to the bending strain until reach the maximum stress (37.2 MPa),(both fiber and matrix remain elastic), after that the stress will decrease until the fracture occurred (the matrix deforms plastically and fibers remain elastic but generally the fibers break before their plastic deformation), the most load was abode by the fibers and not only the matrix (aluminum),which lead to segmented the most fibers and that gesture to the control crack propagation and give the specimens good mechanical properties as shown in table(1), the direction of the fibers (0-90°) was enhanced the ability of the specimens to stand up against the applied load as show in figure (4a-b) the shape(zigzag) of the fracture surface was not straight and the fibers cut off .

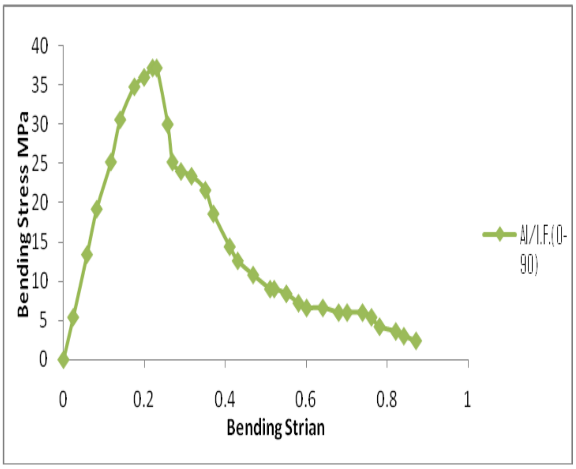
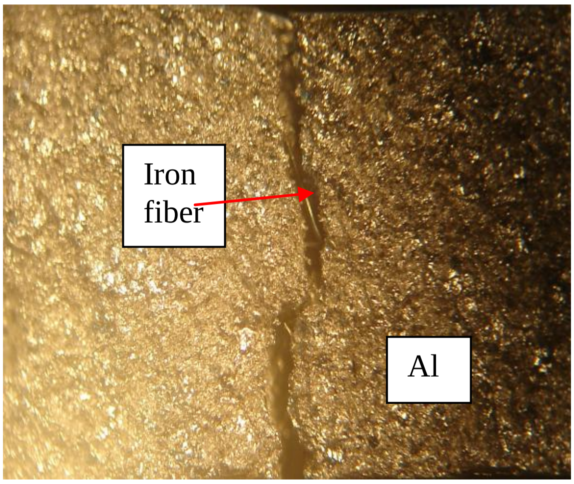


Fig.(3) :Bending Stress-Bending Strain of Al/Iron fiber(0-90°) composite.



(a)

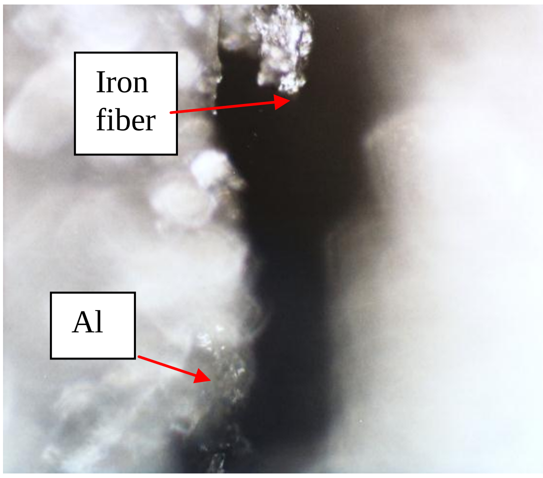


Fig.(4):a) Fracture surface, b) fibers segmented coated with aluminum.

Properties of MMCs largely depend on the reinforcement alignment. A well aligned structure is generally anisotropic in properties (mechanical or electrical), whereas a randomly oriented structure is more isotropic, (14-15). The results of flexure strength for the specimens composite reinforced with iron fibers with direction (0-45°) was shown in figure (5), although the value of maximum bending stress(24 MPa) less than for the specimens composite reinforced with iron fibers with direction (0-90°) but still has good mechanical properties. The distribution of the reinforcements (orientation and homogeneity) plays a key role, the decrease in the maximum stress value can be explain that the applied load was focus on the matrix and because the composites loaded on the middle of the specimen perpendicular to the fiber laminate, the load passing through the matrix and crossed the iron fibers without segmented the most fibers due to the direction of the iron fibers, figure(6) show the fracture surface of the specimens.

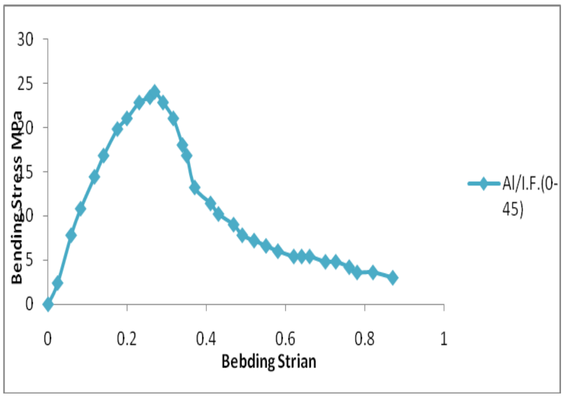


Fig.(5): Bending Stress-Bending Strain of Al/Iron fiber(0-45°) composite.

Table (1):Values of maximum stresses(ơm), yield stresses(Ơy) and young modulus(E) for aluminum composites.

Materials	ơm (MPa)	Ơy (MPa)	E(MPa)
Al/Iron fiber (0-90°)	37.2	34.8	210.944
Al/Iron fiber (0-45°)	24	22.6	118.784

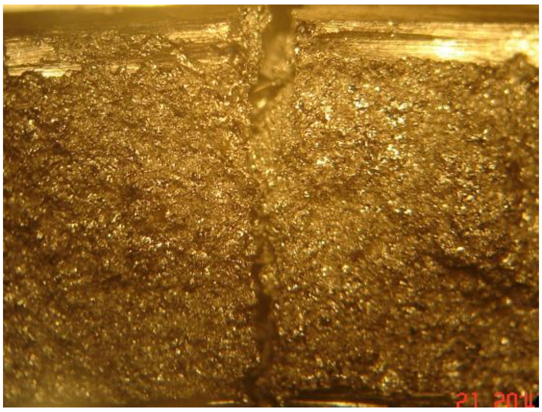


Fig.(6): Fracture surface for aluminum composite (0-45°).

CONCLUSIONS

1- Aluminum matrix composite materials hold great promise for improving performance of pressure vessels and metallic structures.

2- The aluminum reinforced with iron fibers with direction(0-90°) enhanced the value of maximum bending stress than that of aluminum reinfoced with direction (0-45°).

3- The orientation of iron fiber in the
Aluminum composite effected the young modulus values.

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