

On The Way to Fracturedom

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ABSTRACT

During the course of a long career in the field of failure analysis the author had taken a variety of unusual fractographs representing various facets of failure events. Some of these fractographs were found having excellent artistic expression creating charming anatomy of failure, sometimes in the form of an exquisite human eye, deflecting butterfly or cajoled botanical leaf etc., under the propagating skill of fatigue, corrosion or hydrogen embrittlement.

In this paper the author has presented the artistic imprints of various fracture mechanisms through illustration of some of the classic fractographs along with a brief explanation of the metal failure philosophy.

KEYWORDS

Fractograph, Scanning Electron Microscope, Fatigue, Hydrogen Embrittlement, Inclusion.

RESULTS

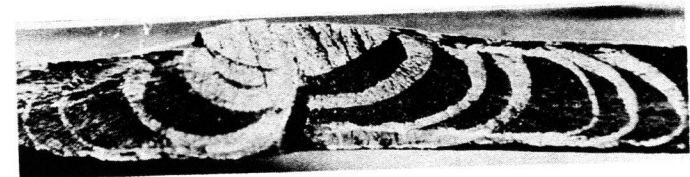


Fig.1 *A fascinating butterfly in a deflecting posture. X 1*

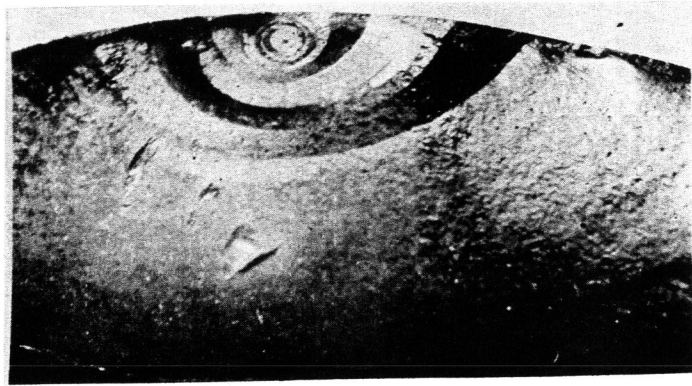


Fig.2 A forlorn human eye in the metallic kingdom. X 3

The above fractographs present here two such classical dances of propagation by fatigue event, leaving their marvellous imprints around the zone of initiation on the fractured surfaces of two critically loaded steel components.



Fig.3 A shy shylock in the metallic society- an unusual art of hydrogen embrittlement attack in the form of a botanical leaf. X 400

The above SEM fractograph presents here a rare combination of beauty recog-

nised as a potential source of danger for hydrogen embrittlement in a high strength steel component.

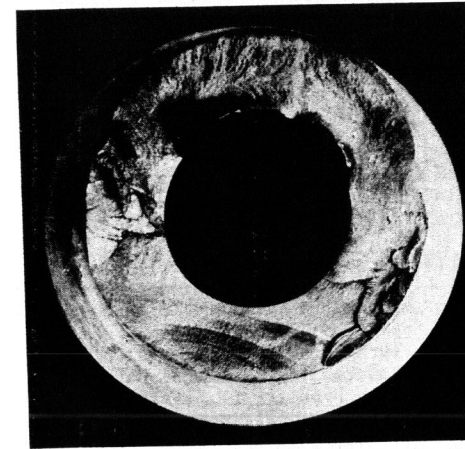


Fig.4 A devastating fracture of an engine propeller blade with unique features of calmness of a fatigue before the turbulence of a storm that snapped away the remainder by overloading. X 0.75

The frightening aspect of the fatigue was discovered due to presence of unnoticed corrosion pits acting as severe notches in the highly stressed blade root radius zone.

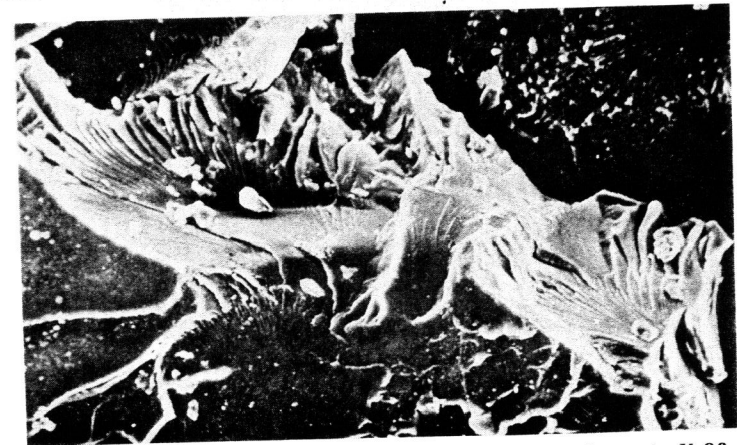


Fig.5 A unique composition of an enraged vulture formed through the stepwise (cleavage) fracture mechanism in a cast perspex (polymethyl methacrylate) material when subjected to tensile impact load. X 30

The above is a classic showmanship of the art during SEM examination of a broken perspex with the flying view of a bird coming down to the earth for a kill.



Fig.6 A display of unique creation of a perspex fracture deflecting the rare composition of a deep sea during its journey through fatigue cracking. X 70

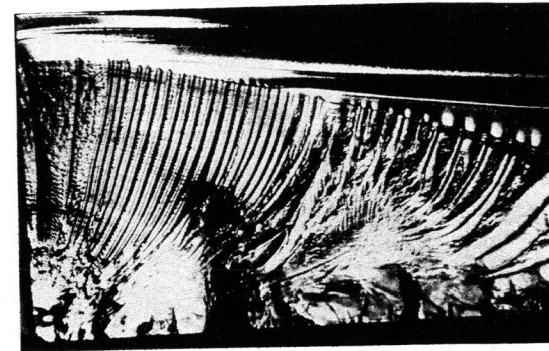


Fig.7 A fantastic resemblance of a typically hand made "Fan shape" structure formed during fatigue crack progression in a cast perspex while performing fatigue testing under 200 psi load condition. X 6

The fractograph shows that a polymethyl methacrylate type cast perspex under fatigue load cycle can create a gentleman like fracture, superimposed with light yet distinguishable signatures of slow moving linear crack fronts across the propagation lines.

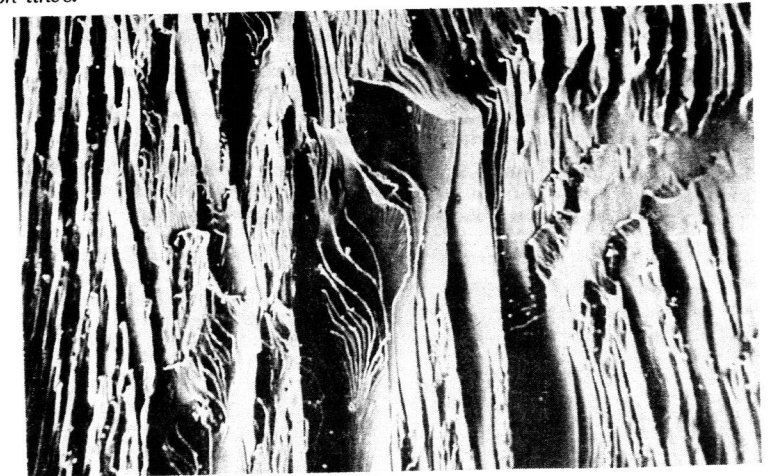


Fig.8 The shattered scenerio of a grim composition drawn out by the disintegrated profile of a non-metallic matrix during knock-off stage of a polymethyl acetate perspex material under the threat of a tensile impact load. X 30

SEM fractograph shows a row of long drawn bundles of pipes crumbling down fast under great flow stresses with signs of severe distortion and at the same time, bursting out the inner intricacies of the snapped off fibres.

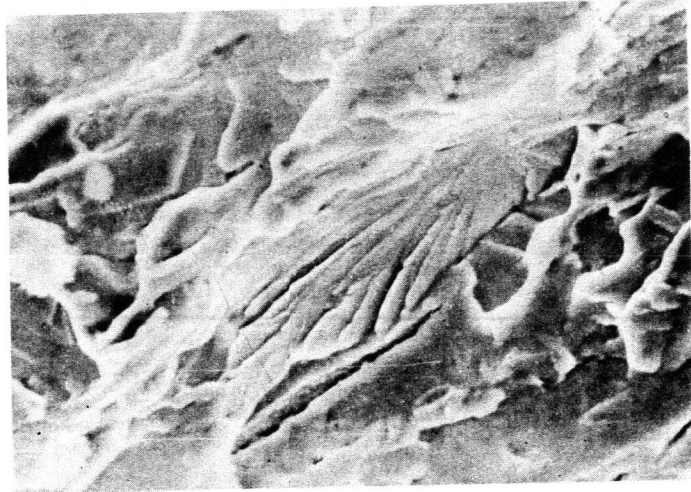


Fig.9 A multifingered hand protruding out of the frozen structure created by a random fracture event in a low alloy steel shell tube during gun firing. **X 400**

SEM fractograph presents very fascinating and recognisable objects like chisel shaped fingers of a human hand, out of rapidity of embrittlement effect with multiples of crack when subjected to rigorous constraints.

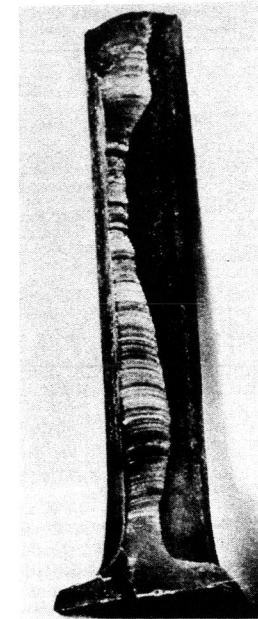


Fig.10 A colossal **X 0.75** art of climbing high up in steps of progression, so perfectly in tune with the well rehearsed cyclic loads and ending in a beautiful fatigue staircase.

The well defined curvature of the 'beach' marks tracing its path from the origin of a hole does not mistake in identifying the purpose till it is exhausted of the vital stress intensity factor.

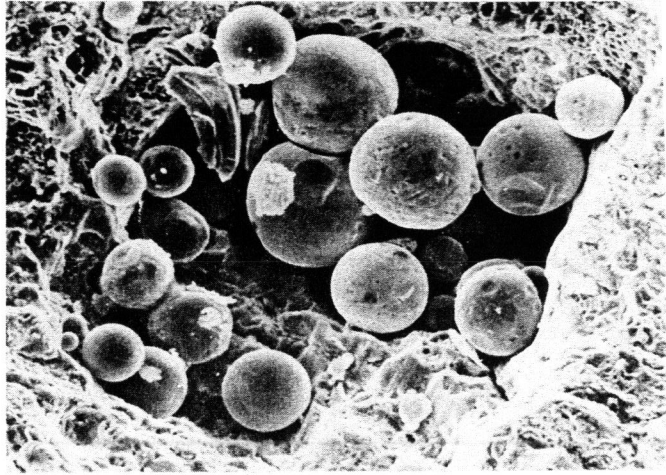


Fig.11 A spectacular view of the enlarged assembly of tiny but deadly inclusions in cluster form, most fearsome in the eyes of metallurgist and designer of the aircraft structure. X 1000

Inclusions as finely disseminated pores induce an element of weakness in the fabric of metallic structure and serve either as dangerous notch for stress concentration or shelter for hydrogen accumulation. The above SEM fractograph indicates the presence of undesirable non-metallic globular oxide inclusions in a highly concentrated form.

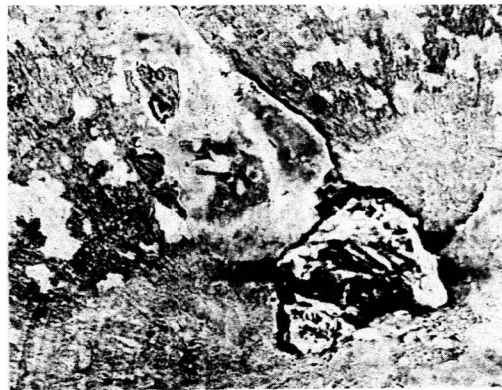


Fig.12 The uncommon and the lone inclusion is tranquil but acted as a culprit with its raised tail of discontinuity which brought out the events of a catastrophic fatigue failure from within the part during flight - an awesome feature of uncleanness and frightening aspects of safety. X 450

The lone hard refractory inclusion that slipped through the various stages of quality control measures into the subsurface zone acted as a potential threat to the life of the part through ultimate choice of fatigue as revealed by the scanning electron microscope.

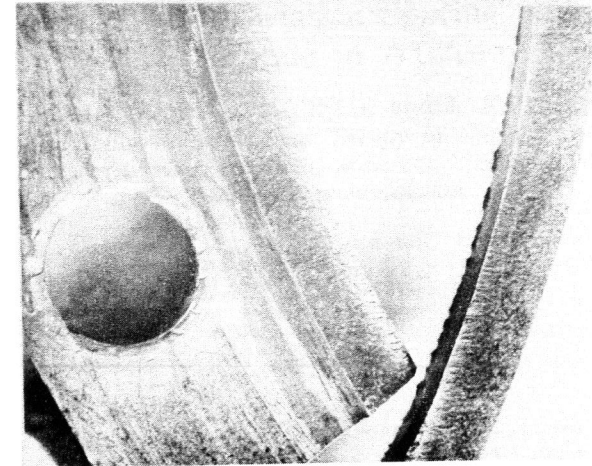


Fig.13 Fatigue by 'Ignorance' defeating all the engineering ingenuities through premature cracking of the steel flange radius of an engine cylinder. X 3

It is sometimes, strange to find out that the root cause of fatigue is meticulously manifested in the envelope of sheer ignorance element of the operator at the assembly level. The fracture is rather a grim picture of elements of ignorance that can play havoc not only with the costly aircraft but also human lives.

CONCLUSION

These fascinating fractographs depicting metallurgical anatomy of the fractures it is hoped will create basic interest towards better understanding of the metal tongue which remained hitherto a silent language for those other than Metallurgist.

REFERENCES

Das A.K. (1987), A La Fractograph, HAL Technical Society, Bangalore.