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0.68 SiC0.2SBR0.12 oil composite tool for superfinishing of En8/Al materials using advanced AFM system

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ABSTRACT: -

This paper shows one of the advanced finishing processes as compared to conventional finishing process and it's required tool's specification along with specialty and analysis.

Abrasive flow machining processes is one of the most advanced finishing processes which is invented in 1960 for deburring process in USA but later it is well-known as advanced finishing process or AFM. This process can give us superfinishing machine members for simple to complex structure. One of the most advantages of this process is that it used to produce micro to nano surface finishing which is the current requirement of most products in this competitive environment. Three basic components of this AFM system are Machine, Tooling and Media. So, media play a major role for the finishing process. Media is nothing but the composites of abrasive, natural polymer as SBR and oil (Paraffin) along with some additives. As we are using abrasive either Silicon carbide, Al2O3, Dimond, boron carbide etc., this is also called as multipoint cutting tool. This is flexible tool which can provide superfinishing at low cost, less finishing time besides very simple machine structure.

No of parameters are responsible for producing the finishing products as raw material's initial structure, types of raw materials, operating process, operating pressure, no of working stroke, stroke time, properties of media like rheological properties, thermal properties, mechanical, chemical properties properties etc. So, media and its characterization or analysis are very important to design the best tool and its combination to improve the finishing standard of a workpiece. So, this paper focus on the composites of multipoint tools along with analysis result. After doing some analysis it has been found that that the combination of 0.68 Sic 0.2 SBR 0.12 oil gives the superfinishing for En8 and Al materials.

Key Words- AFM system.SBR.SiC, Media, Media Analysis

INTRODUCTION: -

After having made the characterization of commercially available media following properties has been observed which are helped to develop the and fabricate the required and needful media. So new media has been fabricated with the reference of existed commercial standard media.

1.Measurement of thermal stability of viscoelastic carrier: -

TGA- Thermogravimetric analysis is an analytical technique used to determine a material's thermal stability and its fraction of volatile components or to identify the decomposition products by monitoring the wight change during heating. The measurement is normally carried out in air or in an inert atmosphere. In addition to weight changes, it is also possible to record the temperature difference between the rested material and reference materials.

The measurement was carried out for commercially available media used in AFM system for sample weight of 5-6 gm with SBR as a carrier.

2. Measurement of crystal structure: -

Commercially available media used in AFM system consists of viscoelastic material, abrasive particles and other additives. Diffraction study was carried by XRD diffractometer.

3.FTIR -Fourier transform infrared spectroscopy -FTIR is used for quantitative compounds of an unknown mixture or to identify the chemical bonds. FTIR studies were conducted by IR spectrophotometer for SBR which is used in commercial media.

FABRICATION OF MEDIA: -

1.Materials – Abrasive – mesh size Alumina-240,400,800.100

SiC-220,400.800,1000

Properties of Abrasive

Alumina	SiC	Properties
Brown	Black	Color
3.98	3.22	Density
2040	2680	Hardness
2.8	1.75	Toughness

2.Process oil: - Naphthenic/paraffin/aromatic oils were used as process oil having following properties

Properties	ASTM	Paraffinic	Naphthenic	Aromatic
Specific gravity	D1250	0.85-0.89	0.91-0.94	0.95-1.0
Pour point	D97	-18 to -9	-40to -18	+0 to +32
Refractive index	D1747	1.48	1.51	1.55
Aniline point	D611	95-127	65 -105	35-65
Molecular weight	D2502	320-650	300-460	300-460
Aromatic content	D2007	19-30	20-40	35-85

3.SBR—Styrene butadiene rubber (SBR) are used to prepare the media.

Properties: -

Properties	Average Value
Bound styrene (%)	23
Volatile matter (&)	0.75
Mooney viscosity ML at 100^{0}C	52
Ash content (%)	1.50
Stabilizer	Non

Formulation; - The percentage ingredients by weight for each formulation is given by

% of particular ingredients = (Weight of particular ingredients / Total weight of compound) X 100

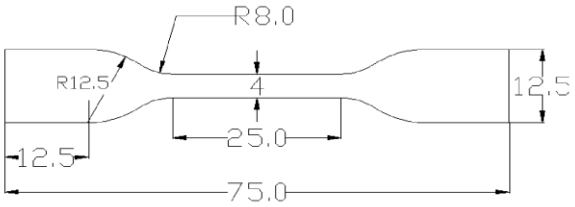
MIXING OF ABRASIVE IN VISCOELASTIC CARRIER: -

The mixing of abrasive particles and process oil was carried out an open two-roll mill (150mm diameter roll,7.5 HP) with friction ratio of 1: 1.1 and temperature of 50^{0}C to 75 ^{0}C supplied by Slash Hydrate Equipment Pvt Ltd-India. The clearance between roll was adjustable from 0.2 mm to 8 mm. The mixing was performed as per the ASTM D3182-89 with mastication (break down of molecular chain) of viscoelastic carrier. This is essential because it improve the acceptability of viscoelastic carrier for abrasive and additives (if any) and ultimately promotes the uniform dispersion. The batch was cut ¾ of the distance across the roll with the help of knife and held the knife at this position until the bank just disappears. Next successive ¾ cuts made from alternate ends of the roll. Allowing 20 sec. between each cut. After sufficient mastication the pre-decided abrasive added evenly across the roll at uniform rate. The total oil quantity was added alternatively in small-small quantity with abrasive. The falling material collected carefully and added back to the mix. For ensuring uniform dispersion batch is pass six to eight times through mill with opening of 0.8 mm and finally passed four times with opening of 6 mm

CHARACTERIZATION OF MEDIA

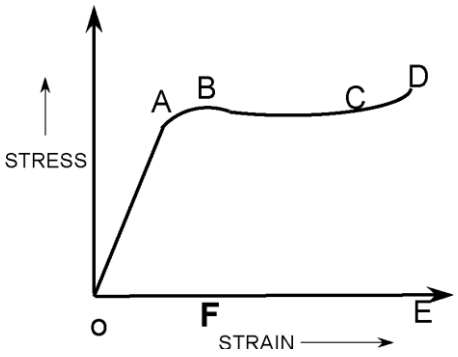
Following graphs has shows the basic characteristics of the media along with variation of the result. Media performance are depending on the specific properties, physical properties, chemical properties, rheological properties etc. of the media and also ingredients percentage.

Stress-strain diagram of media -Through stress strain diagram it is possible to justify the performance of media under loading condition means actual working condition.

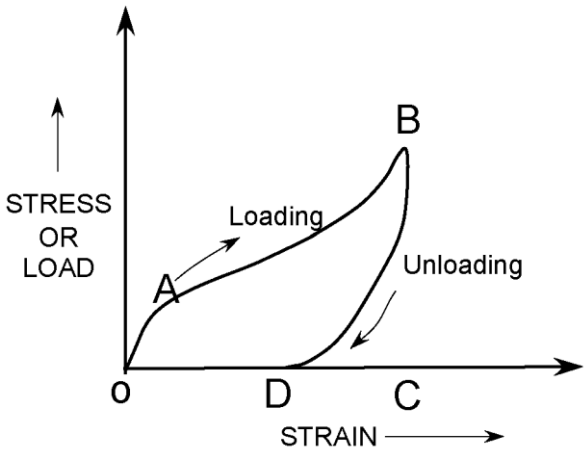


(ASTMD412-98a)

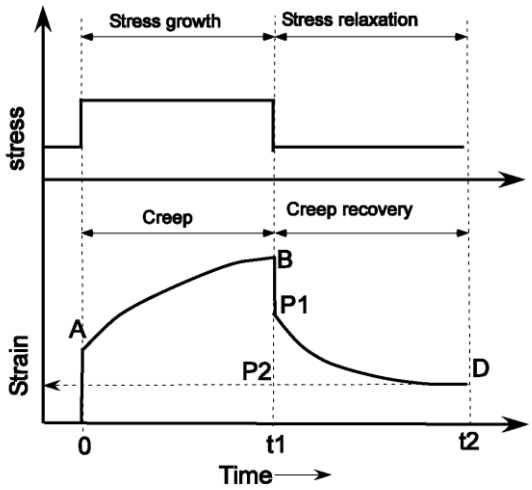
Various test has been conducted to check the performance of the media and observed the various mechanical properties as elasticity, resilience, stiffness, modulus, creep etc. Following graph shows the behaviors of the media under temperature range of the 25 to 55^{0}C with maximum load of 10 kN.



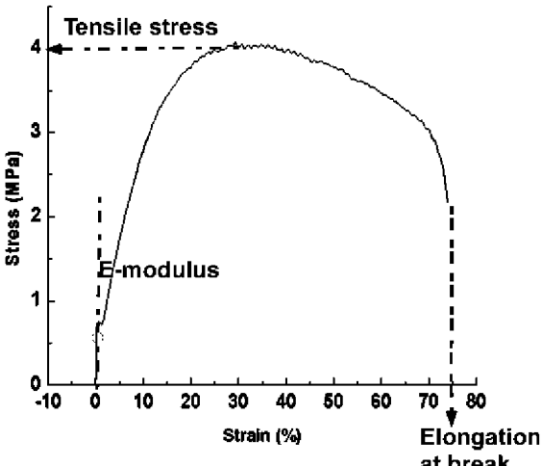
Stress-Stain diagram



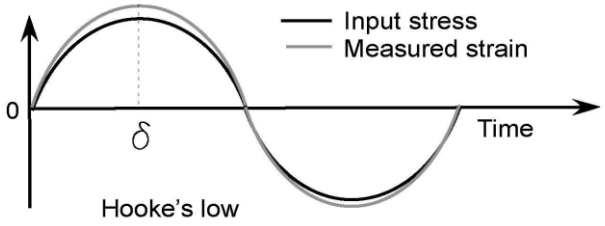
Hysteresis Loop



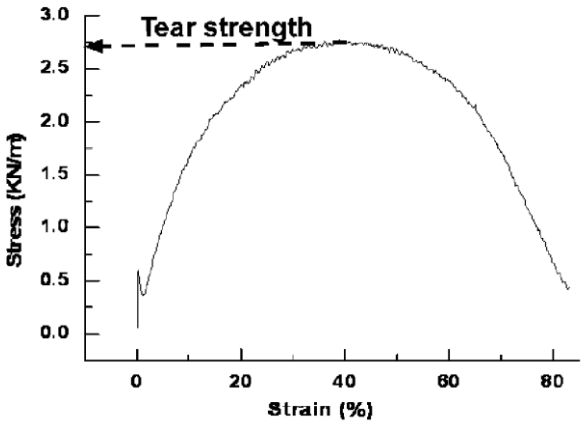
Measurement of Creep



Measurement of Tensile strength



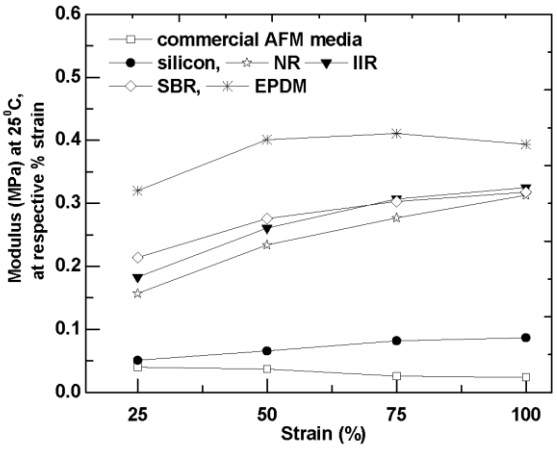
Measurement of oscillation



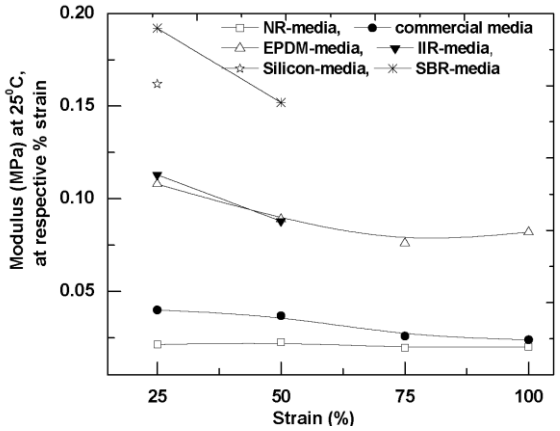
Measurement of Tear strength

PERFORMANCE OR ANALYSIS OF MEDIA: -

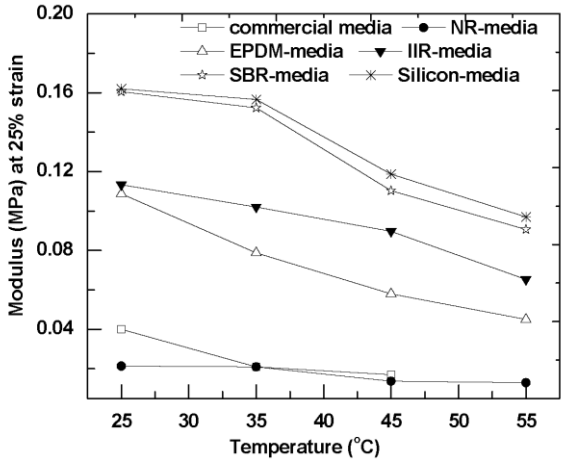
Media performance are analyzed by doing the finishing operation on the workpiece like En8 and Aluminum using AFM system. Before performing the operation clean the material with acetone and measured its initial value of hardness and surface roughness. Materiel should be free form textures and should be prepared by precision machine so that it led to yield superfinished materials. Roughness value are measured by standard surface roughness Tester as Model SJ301.



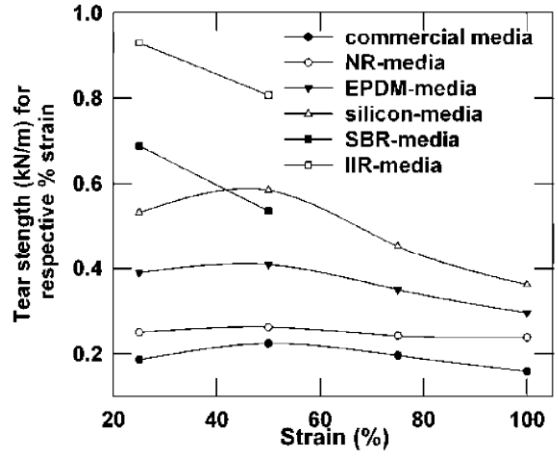
Effect of strain on modulus under tensile mode



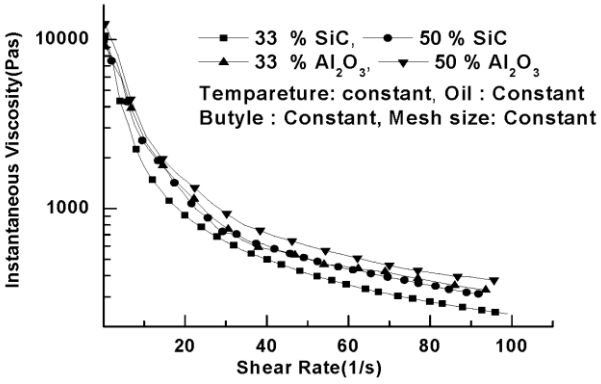
Effect of strain on Modulus at 25 ^{0}C for the combination of 0.68SiC 0.2 SBR 0.12oil under tensile mode



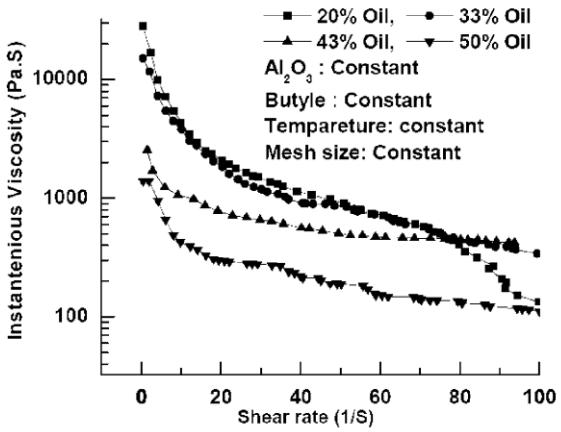
Effect of temperature on modulus using various viscoelastic materials under tensile mode.



Effect of Strain on tearing strength of viscoelastic media.

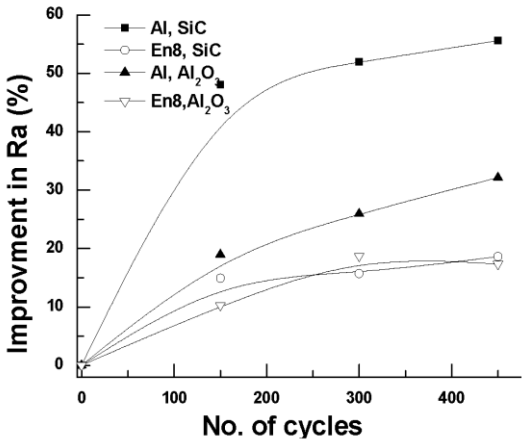


Effect of shear rate on viscosity by changing types of abrasives. (Rheological Test)

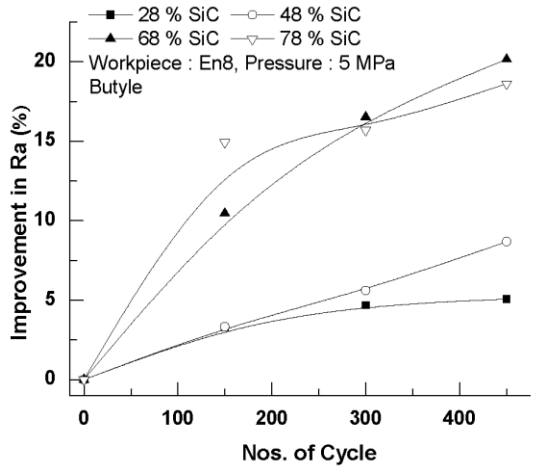


Effect on shear rate on viscosity of various percentage of oil.

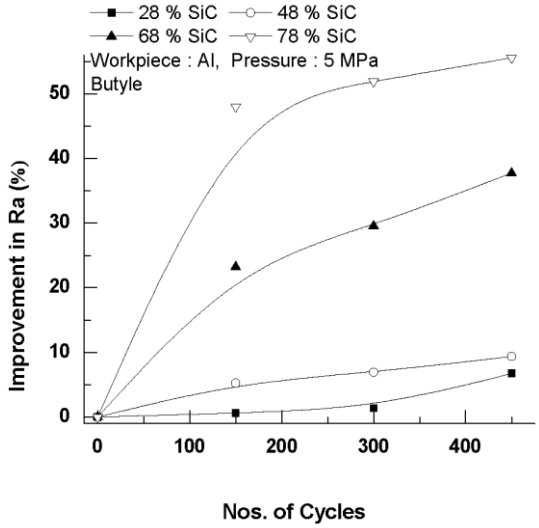
RESULT



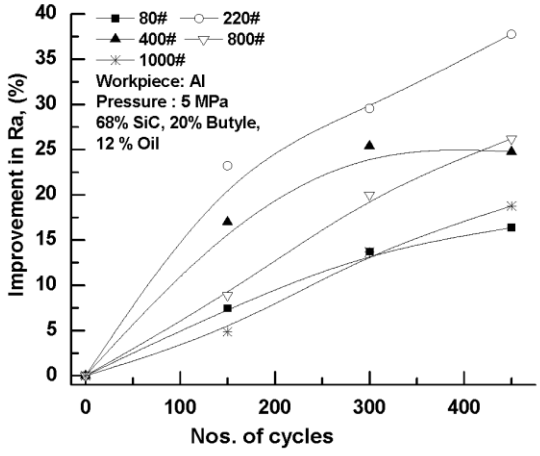
Effect of number of cycles on Ra value



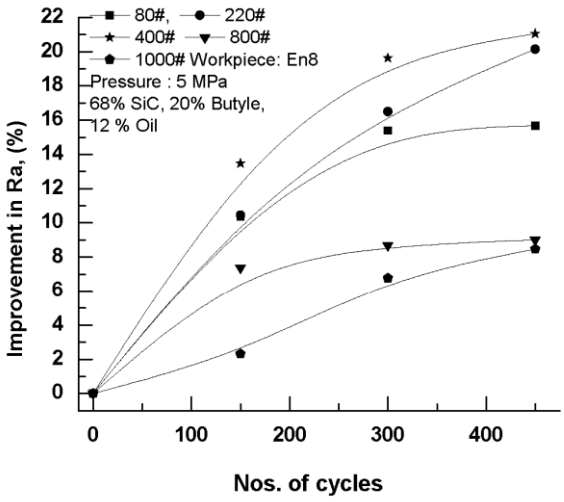
Effect of number of cycles and Roughness Ra value For En8 material.



Effect of number of cycles and Ra value for Al material

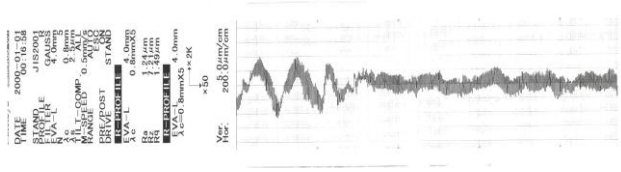


Effect of Number of cycles on Ra value for the combination of 0.68 SiC0.2SBR0.12oil for Al material

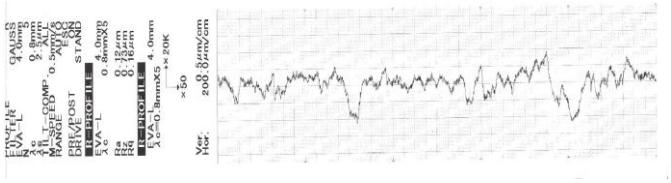


Effect of Number of cycles on Ra value for the combination of 0.68 SiC0.2SBR0.12oil for En8 material

SURFACE ROUGHNESS ACTUAL RESULT



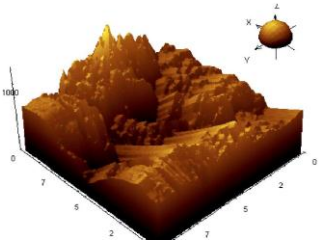
1. Initial Ra=1.24 micron on En8 for continuous finishing using 220,400,800and 1000 mesh size for 450 cycles with 5 MPa pressure.

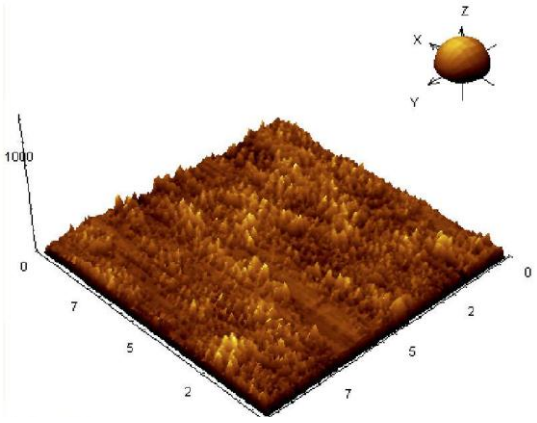


2. Final Ra=0.120-micron micron on En8 for continuous finishing using 220,400,800and 1000 mesh size for 450 cycles with 5 MPa pressure.

Surface topography taken by Atomic Force Microscope for En8

Initial





Final Surface topography by AFM for En8 material.

CONCLUSION-

After having made the result analysis of media and its performance status it is infer that media characteristic play a major role for the improvement of the finishing of the surface. Operating environment and composition of media can give us micro to nano finished structure. Study has been shown that abrasive types, percentage, viscoelastic carrier, oil and other additives, operating pressure, number of cycles are major governing parameters for the superfinishing of the materials. Under proper selection criteria and analysis using advanced technique can be improved the performance of AFM-system to improve the quality of the product and also help to achieve superfinished products.

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