Finite Element Analysis on Vehicle Bumper Using Springs

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Abstract:

Automobile design with safety and given economy has been a great challenge to engineers in design section. Bumper is main role acting on vehicle which is used in protection of passengers and also protection of a front and rear ends of vehicle from collision. The safety part of the total vehicle act in bumper it act an import role in vehicle, now day's bumper part are used in vehicle which connect to front and rear ends when directly to chassis .so when act in collision in vehicle are happened the impact forces to transfer the remaining parts through linkage. There is no innovative mechanism to reduce the impact forces. In this present work, a moderate type of bumper system was developed by using the addition of springs to the system and also an alternate material for the bumper is used in place of the existing material. The designed process is carried out by using CATIA and structural analysis is done by ANSYS software. The obtained results show that the use of springs and also alternate material to the bumper leads to reduce in total deformation, strain energy, maximum principal stresses and maximum shear stresses. These results are also shown by using graphs.

I. INTRODUCTION

Every day automotive vehicle accident is happening. Automotive designs is reduced, security and aesthetics have a design engineers are great challenge in this design. . The safe of passengers in total during vehicle accident can during safeguarded to a maximum limit by using good bumpers. In automobiles and heavy automotive vehicles bumper is use in front and rear of vehicle as safety process. It made in such a way that it takes maximum impact of automotive vehicle and then after accident it goes direct the chassis. The many of research is done in this field on material and good design basis. The most of automotive vehicle use bumper which made from steel, light material such as aluminium, polymers and many more materials. Now a day the many bumpers that we have seen on vehicle is directly connected to chassis, so there is solid to solid contact on vehicle between bumper and chassis, furthermore no place is kept between bonnet and bumper all they make closed contact.

Bumper system that connected to vehicle chassis of vehicle with no space between bonnet and bumper so that after vehicle accident impact moving in linkage, and problem, and damage on bonnet, engine and also to effect on drive cabin and travellers. But in this paper we proposed new moderate bumper system in such a way that it will break the linkage of impact which is add by solid to solid contact, by using helical springs with maintaining the space between bumper and chassis bonnet. Bumper system is moderate to safety or reduces physical damage to vehicle front and back ends of passenger motor vehicles in accident condition. The protected truck, grill, fuel, exhaust and cooling system as well as safety related equipment such as parking lights, headlamps and taillights, etc

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II. LITERATURE REVIEW

Anderson has discussed that to developed crash performance in automotive vehicles it is generally to use new techniques such as use of energy absorber and also absorber the impact load by use of give materials. Vehicle components linked to crash safety purpose should transmit or absorb energy and deflection. The energy absorbing in different materials properties .The given use of material should have high yield strength and relatively high elongation to fracture. These demands lead to increase interest to use of high strength and absorbing energy for stainless steels.

Bautista studied the different impact loads standards and for the specific given

material they optimized the shape and size of bumper beam by performing the software simulation. They also studied the effect of metallic energy absorber and also absorber vibration energy in bumper system. Maximum stress and total deformation of normal bumper and moderate bumper were used as design criteria. They have complied many international standards for bumper beam design.

Prewrote discusses about automotive suspension coil springs, it so many type of spring and different type materials. It many function are used in spring is a helical spring their fundamental stress distribution, materials characteristic, manufacturing and common failures. An in depth discussion on the parameters influencing the quality of coil springs is also presented.it depend on pitch length of spring and number no coil in spring and also height of spring. The main part of the design spring of a given dimension.

III. DESCRIPTION ABOUT THE BUMPER AND SPRING

A vehicle bumper is fitted in vehicle front and rear ends so it absorb an impact loads and to reduce the damaging of vehicle in front and rear sides.to protract the vehicle front and rear ends and also can during safety guard of vehicle.

Bumpers are main important part acting on vehicle two safety functions: minimize height gaps between vehicles and protecting foot-travelers from damage. Then British govt. inventor Frederick Simms developed bumpers in 1901.

1) Steel Bumper

Steel bumper very strong material it is used in heavy vehicle it absorbed high impact load. Really covered steel was used for the entire body of a vehicle front and back side (like car) and also together with the bumper. In this material functioned well, as it was high durable in a collection, but it have to withstand heavy loads and give the best performance. As car components design in improved in this materials. In classic cars to have use in steel bumper it much be disappeared for anything.

It exchanging on lot of waist scape it involves at lot searching of car scrap it having on specially made.

2) **SPRING** The spring is acting on these project major role it has defined as an elastic body, the function of the spring distort when loaded and also recover its normal position he as load to remove for this spring operation. In spring has it main role acting on mechanical side. It absorbs the impact and compressive loads on given objects. Springs has generally to use of materials have steel.

IV. PROPERTIES OF BUMPER AND SPRING MATERIALS

Bumper Properties Structural steel it is a category of steel used as a construction material for make structural steel shapes. A structural steel shape is a, formed with a specific cross section and following certain standards for chemical composition and mechanical properties.

1) Structural steel chemical properties

TABLE 1
Structural steel chemical properties

CONSTITUENT	PERCENT
Carbon, max	0.17
Manganese, Min	0.4
Silicon, Max	0.26
Sulphur, Max.	0.04
Phosphorous, Max	0.02
Aluminium, Min	0.03

2) Mechanical properties

TABLE 2
Mechanical properties

PROPERTY	GRADE
Compressive Yield Strength	250 MPA
Tensile Yield Strength	250 MPA
Tensile Ultimate Strength	460 MPA
Modulus Of Elasticity	210 GPA
Density	7.85 kg/m3
Poisson's Ratio	0.3

3) Bumper parameters

TABLE 3
Bumper parameters

Parameter	In mm
Length	1500
Height	200
Thickness	3

4) Spring Properties

TABLE 4
Spring material

Category	Steel
Class	Carbon Steel
Grade	1065
Standard	AISI

5) Chemical Properties

TABLE 5
AISI 1065 carbon steel chemical properties

ELEMENT	ELEMENT
Manganese	Manganese
Carbon	Carbon
Sulphur	Sulphur
phosphorous	phosphorous

6) Spring Parameters

TABLE 6
Spring Parameters

PARAMETERS	IN mm
Free length	**200**
Spring wire diameter	**8**
Diameter	**65**
Pitch	**16**
No of coils	**12**

V. MODELING BUMPER

1) Modeling

The normal bumper and spring attachment both models are created by using catia software.CATIA (a restriction of **computer aided three-dimensional interactive application**) is design of multi-platform computer-aided design (CAD) / computer aided manufacturing (CAM)/computer-aided engineering (CAE) software suite developed by the French company Assault Systems. It is also language in the C++.

TABLE 7

CATIA	Column1
Developer(S)	**Dassault system**
Initial Release	**1977, 39 Years Ago**
operating system	**Windows / Unix (Server)**
Type	**Cad, Cam, Cae, Plm, 3d**
License	**Proprietary Software**

CATIA (computer aided three-dimensional interactive application) than started as an in home improvement in 1997 aircraft manufacturer circumvents marcel dassault, that the anytime customer of the cad/cam official software and to develop assault's fighter jet. It also developed the aerospace, shipbuilding and automotive etc.

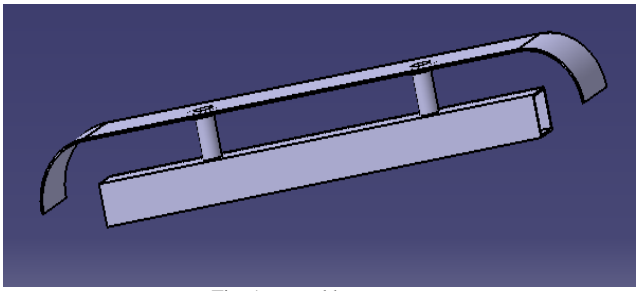

Fig. 1 normal bumper

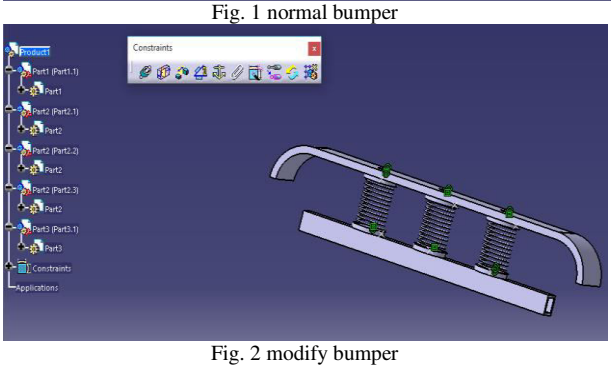

Fig. 2 modify bumper

VI. ANSYS

1) INTROCTION OF ANSYS

a) ANSYS AIM demonstrates the vision of ANSYS 3D Multi physics Simulation in ANSYS Workbench. In part, ANSYS AIM offers.

b) An integrated single window display for end-to-end simulation, including geometry, meshing, solution, post-processing and draw point evaluation.

c) A guided simulation process through the use of templates and task-based windows.

2) STRUCTURAL ANALYSIS

The Structural template defines a basic structural simulation process that can be used to simulate and evaluate the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects.

Before you create the simulation process, the options in this template are:

• Physics

o Select Structural only when you want to determine the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects.

o Select Structural and thermal when you want to model situations where the temperature field introduces thermal strains in the structural field, which, in turn result in thermal expansion and stresses.

o Select Structural and electric conduction when your simulation requires structural and electric conduction loads on a system or component.

o Select Structural, thermal, and electric conduction when you need to model situations where electric effects create thermal effects, and where thermal effects cause structural strains and deformation.

2) NORMAL BUMPER

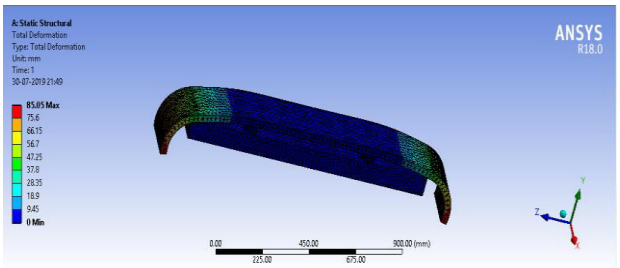

Fig. 3 Total deformation

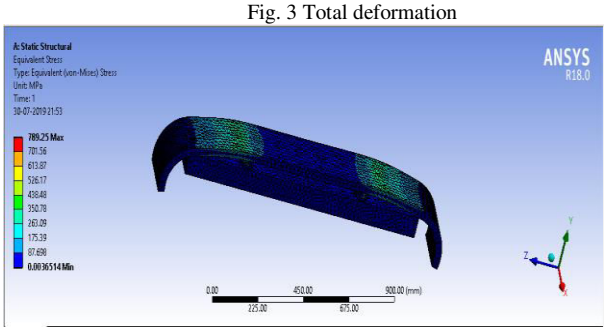

Fig. 4 equivalent stress

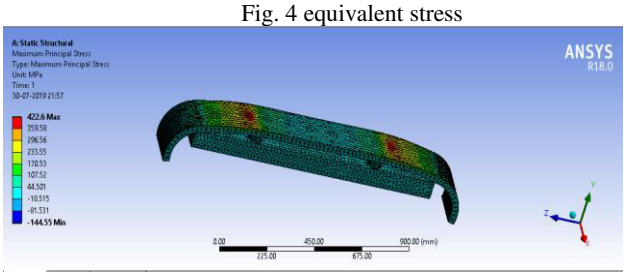

Fig. 5 maximum principal stress

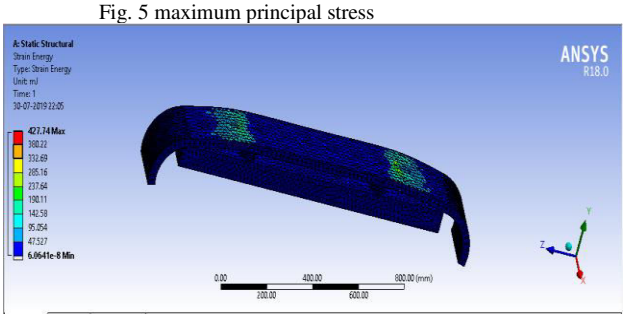

Fig. 6 strain energy

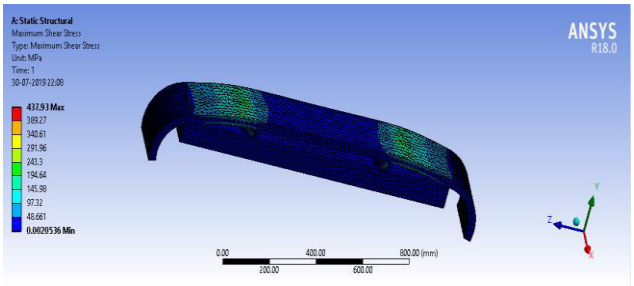

Fig. 7 maximum shear stress

3) MODIFY BUMPER

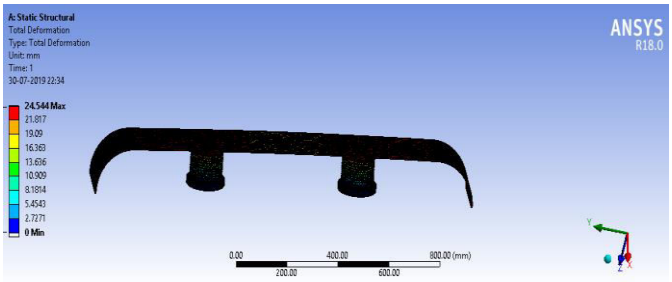

Fig. 8 Total deformation

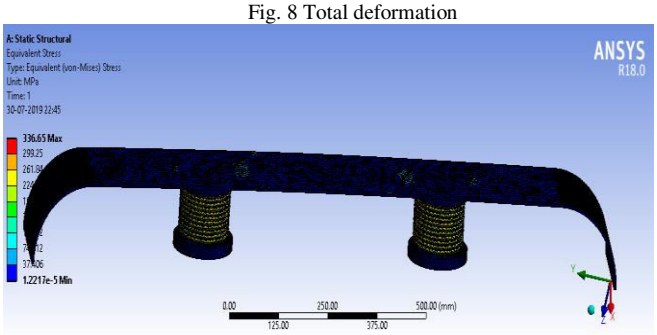

Fig. 9 Equivalent stress

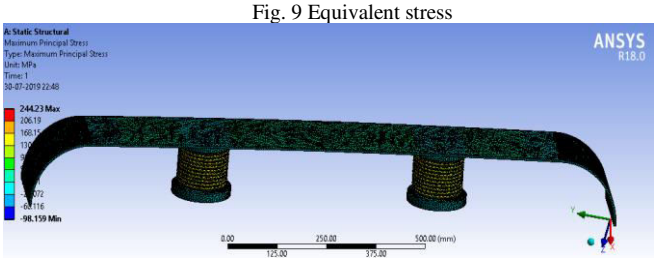

Fig. 10 maximum principle stress

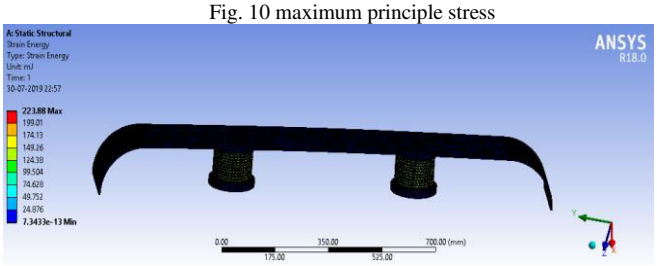

Fig. 11 strain energy

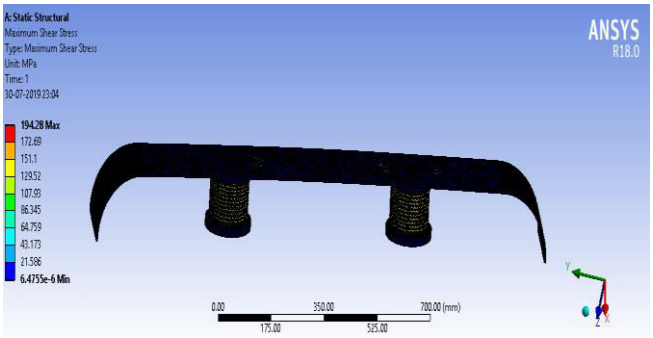

Fig. 12 maximum shear stress

VII. RESULTS

Results of total deformation

Table 8

Result type	Normal bumper	Spring attachment bumper
minimum	0	0
maximum	85.05N/m^2	24.817N/m^2

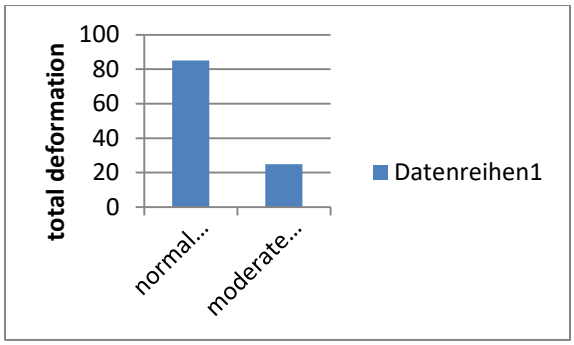

Fig.13 total deformation

If compare to the normal bumper to spring attachment bumper is reduce the deformation. Because of the moderate bumper to attached spring so that absorbed impact loads. To different between the normal bumper and moderate bumper to improve the performances of bumper. To reduce the total deformation and improve the safety of vehicle.

Results of equivalent stress

Table 9

Result type	Normal bumper	Spring attachment bumper
minimum	0.003N/m^2	1.2N/m^2
maximum	789.25N/m^2	336.65N/m^2

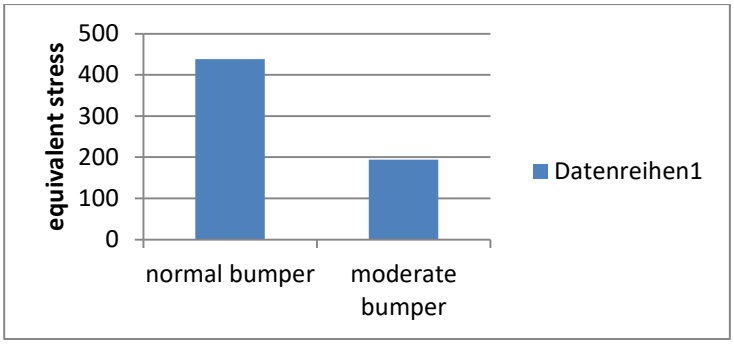

Fig. 14 equivalent stress

If compare to the normal bumper spring attachment bumper is reduce the equivalent stress. Because of the moderate bumper to attached spring so that absorbed impact loads.it show the graph the equivalent stress to reduce the normal bumper to moderate bumper and its improve the performance of vehicle bumper.

Results of maximum principle stress

Table 10

Result type	Normal bumper	Spring attachment bumper
minimum	0	0
maximum	422.6N/m^2	244.23N/m^2

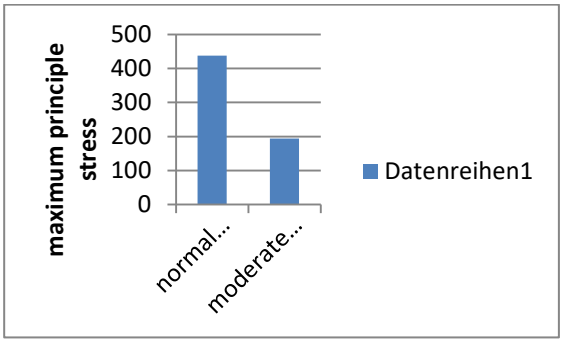

Fig. 15 maximum principle stress

If compare to the normal bumper to spring attachment bumper is reduce the maximum principle stress. Because of the moderate bumper to attach springs so that absorbed impact loads.

Result of strain energy

Table 11

Result type	Normal bumper	Spring attachment bumper
minimum	7.345N/m^2	6.06N/m^2
maximum	427.74N/m^2	223.188N/m^2

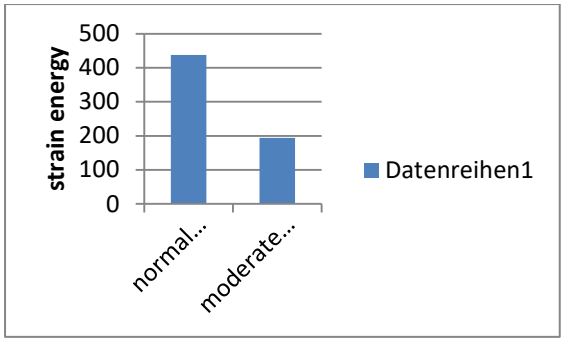

Fig. 16 strain energy

If compare to the normal bumper to spring attachment bumper is reduce the strain energy. Because of the moderate bumper to attached spring so that absorbed impact loads.it graph are show the two difference between the normal bumper and moderate bumper to reduce strain energy. To improve the to absorbs the energy them to attested the springs.

Result of maximum shear stress

Table 12

Result type	Normal bumper	Spring attachment bumper
minimum	6.477N/m^2	0.002N/m^2
maximum	437.93N/m^2	194.28N/m^2

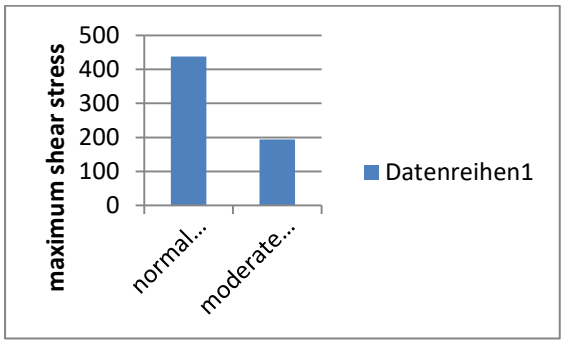

Fig.17 maximum shear stress

If compare to the normal bumper to spring attachment bumper is reduce the maximum shear stress. Because of the moderate bumper to attached spring so that absorbed impact loads.

VIII. CONCLUSION

The moderate bumper is successfully developed using the additional springs of a bumper by using of alternative materials. Analysis of modern bumper compared with normal bumper total deformation, strain energy, maximum principle stress and maximum shear stress reduced. By the obtained results we concluded that the moderate bumper is best results and to reduce damage of the bumper also increase the safety of passenger compared to the normal bumper.

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REFERENCES

1. Kuziak .R. Kawalla, R.waengler.s. ―Advanced high strength materials for automotive industry A review ‖ Journal of Archives of Civil & Mechanical engineering .volume 8 issue2, 2008-12-30 ,Pages 103-117

2.Marzbanrad J M, Alijanpour M, and Kiasat MS, ―Design and analysis of automotive bumper beam in

Low speed frontal crashesh ‖, Thin Walled Struct., PP 902-911, 2009.

3. Mohapatra S, ―Rapid Design Solutions for Automotive Bumper Energy Absorbers using Morphing Technique ‖, Altair CAE users Conference, Bangalore, India. 2005.

4.Andersson R, Schedin E, Magnusson C, Ocklund J, ―The Applicability of Stainless Steel for Crash Absorbing Components ‖, SAE TechnicalPaper,2002

5.Falai chen , Bert Juttler, ―Geometric Modeling& Processing ‖, Journal on CAD, volume 42 issue1 pages 1- 15

6.David H. Allen ―Structural Analysis, Aerospace ‖ Journal on Encyclopedia of Physical science and technology 3rd edition 2003

7.T.D. Gillespie (1992), ―Suspensions in fundamentals of vehicle dynamics ‖, society of automotive engineers, USA, pp.97-117 & pp.237-247.

8.V. B. Bhandari (1994), ―Design of machine elements ‖, New York, Tata McGraw-Hill.

9.R.S. Khurmi& J.K Gupta (2003), ―A textbook of machine design ‖, S. Chand & company.

10.Ansys v12.1 Manual, // Mechanical (formerly Simulation) // The Mechanical Application Approach // Analysis Types //

11.Hibbeler, R. C. (2002). Structural Analysis, Pearson Education (Singapore) Pte. Ltd., Delhi, ISBN 81-7808-750-2

12.Leet, K. M. and Uang, C-M. (2003). Fundamentals of Structural Analysis, Tata McGrawHill Publishing Company Limited, New Delhi, ISBN 0-07-058208-4

13.Negi, L. S. and Jangid, R.S. (2003). Structural Analysis, Tata McGraw-Hill Publishing Company Limited, New Delhi, ISBN 0-07-462304-4

14.Carrie M. Tamarelli, ―The Evolving Use of Advanced High-Strength Steels for Automotive Applications ‖, Materials Science and Engineering University of Michigan, 48075, 2011.