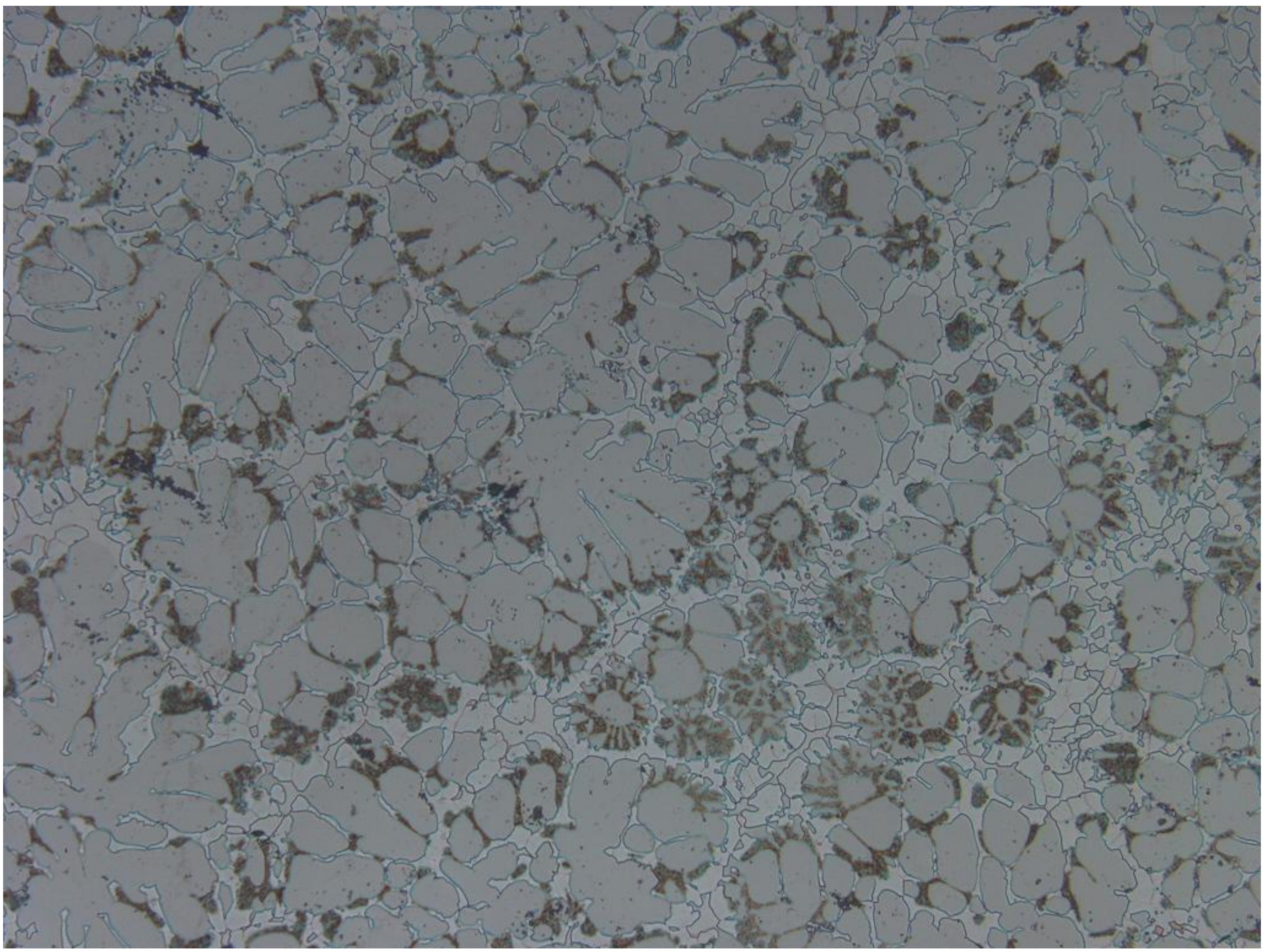
e-METNEWS – VOICE OF IIM, TRIVANDRUM CHAPTER

Metallurgy
Materials Engineering

Editors

Dr. S. V.S. Narayana Murty, Dr. M. Ravi,
Dr.T.P.D.Rajan and V. Anil Kumar



Optical photomicrograph of Al-Cu-Co-Ni-Fe High Entropy Alloy processed by Vacuum Induction Melting in as cast condition-Magnification 500X (Courtesy: Niraj Nayan and S.V.S. Narayana Murty, MMG, VSSC)

Message from Chairman, IIM Trivandrum Chapter

Dear members of IIM Trivandrum Chapter,

As the present Executive Committee is stepping in to the second year in office, I would like to inform you all that the past year was very fruitful and eventful with many programmes such as the hugely successful international conference ICAMPS-2012, six technical lectures by eminent material scientists, BP lecture by Dr. S Sundarrajan, Director, NIT, Trichy and the Chapter Day celebration. I thank every one of you for your support, co-operation and encouragement in carrying out the tasks effectively. I solicit similar response from all members in future also so that the EC can go ahead with the planned activities such as an international workshop on high temperature materials and hot structures, Chapter Day, BP Lecture and probably a national Microstructure seminar apart from other regular events.

I am very happy that the EC is bringing out the new issue of Met News coinciding with the Annual General Body Meeting 2012. As part of the movement to 'go green', EC has decided to bring out "e-Met News" from this issue onwards and henceforth the same will be available in electronic form only. The Editorial Team comprising of Dr. S. V.S. Narayana Murty, Dr. M. Ravi, Dr.T.P.D.Rajan and Shri. V. Anil Kumar has done a commendable work in bringing out this issue. I also thank all contributors of articles to the Met News. I further request all members to contribute technical articles and member news for the future issues of the same.

With best regards,
Dr. M R Suresh

From the Editors' Desk

The editorial committee has great pleasure in informing its members and readers that the MET NEWS has successfully completed twenty nine years of its publication and marching towards greater heights in the dissemination of information related to the field of metallurgical and materials science and engineering. It also serves as a communication platform for its members and readers in exchanging their views, achievements and exciting R&D results of the individuals. We request all the members and readers to contribute to the issue of MET NEWS in the form of articles and short messages and make it a memorable one. Our hearty congratulations to the members who brought laurels to themselves and to the chapter during this year. The timely advice and guidance extended by the senior members and other wellwishers are greatly acknowledged. We are grateful to the authors who have contributed articles for the present issue and hope to receive the same encouragement in future also.

Beginning with this issue, it has been decided by the executive committee to bring out MET NEWS in electronic version which will be sent to all members by e-mail. We sincerely hope that you will enjoy reading the electronic version of MET NEWS.

- Editors

TEXTURE IN METALS AND ALLOYS - AN OVERVIEW

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Microstructure in materials is very important in deciding the properties. These microstructures are considered to be a combination of morphology and orientation of the constituents. The morphology refers to shape of the constituent and the orientation to its crystallography. Hence, texture is a constituent feature of microstructure. Texture is derived from the latin word " textor", meaning ***weaver***. In the context of materials, texture referes to how a material is woven with crystals. In other words, one can define texture as the arrangement of building blocks in polycrystalline material. Fig.1 below show a sheet of polycrystalline material depicting two situations where the constituent grains are crystallographically differently arranged (random polycrystal) in (a) and in (b) the constituent grains are crystallographically similarly arranged (single crystal).

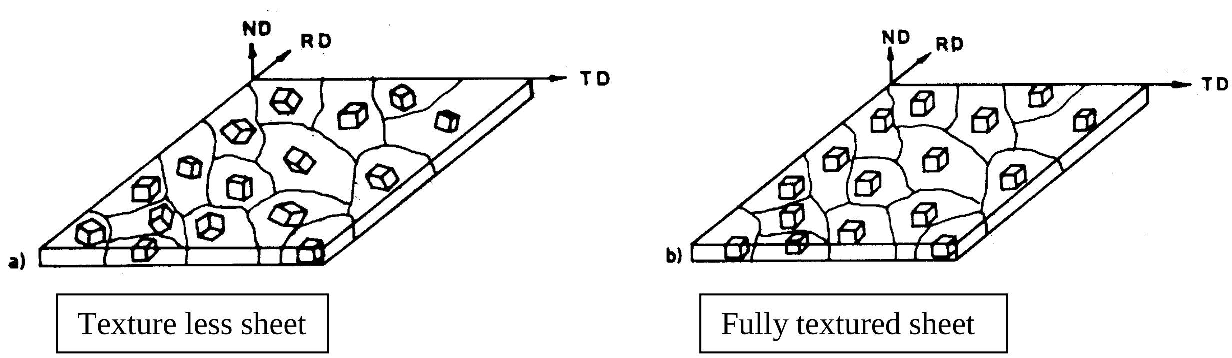


Fig. 1(a) and 1(b) shows a sheet of plycrystalline material depicting two situations

The aim of the materials scientists engaged in texture research is to develop materials with favorable properties. One example is the development of silicon steel with favorable texture. The properties of polycrystalline materials depend on the individual properties of the single crystals and also on parameters characterizing the polycrystalline state. Most of the metallic materials are prone for texture when heavily cold worked. Texture influences the following properties: Elastic modulus, yield strength, tensile ductility and strength, formability, fatigue strength, fracture toughness, stress corrosion cracking, electric and magnetic properties and many others. Measurement of texture will help to understand the effect of process parameters and their effect on the properties.

Representation of Texture

For uniaxial deformation or other processes, texture is described by miller indices of directions [*uvw*] aligned along the specimen axis. For biaxial deformation, like rolling, it is described by a combination of miller indices of sheet plane and the miller indices of the directions parallel to the longitudinal axes. Thus the texture in a rolled sheet material is commonly represented by {*hkl*}[*uvw*], which means the {*hkl*}planes of these grains lie parallel to the sheet plane, whereas their [*uvw*] direction point parallel to the rolling direction. For materials with only one important dimension like extruded rods, wires, thin films, any one of these sets are used to describe texture. Elongated or flattened grains do not imply a certain texture, or even the presence of texture at all. On the other hand, presence of equiaxed grains does not imply a random orientation. Plastic strains near the surface of a specimen may differ from those in interior – especially in rolling and wire drawing and may produce textures that vary with depth below surface which introduces texture heterogeneity or texture gradient. To get a true picture of the texture developed during rolling, forging etc., texture at the mid thickness (T/2) is measured.

The deformation texture developed in pure metals as well as alloys with FCC crystal structure are predominantly of two types, pure metal or copper type and the alloy or the brass type. The copper type texture has four major components, namely, Cu orientation {112}<111>, Bs orientation {011}<211> , S orientation {123}<634> and Goss orientation {011}<100>. In the alloy type texture, there are a very strong Bs and a relatively weak Goss component (Wenk and Van Houttee, 2004).

Methods of Measuring Texture

Many methods have been proposed to determine preferred orientation. Optical methods have been extensively applied by geologists, using the petrographic microscope equipped with a universal stage to measure the orientation of morphological and optical directions in individual grains. Metallurgists have traditionally used a reflected light microscope to determine the orientation of cleavages and etch pits. With advances in image analysis, shape preferred orientations could be determined quantitatively and automatically with stereological techniques. As far as crystallographic preferred orientation are concerned, diffraction techniques are the most widely used ones (Bunge, 1982,1999 , Kocks et al.,2000). X-ray diffraction with a pole-figure Goniometer is generally used for routine texture measurements. For some applications synchrotron x-rays provide unique opportunities. Neutron diffraction technique similarly offers some distinct advantages, particularly for bulk texture measurements of thick samples. Electron diffraction using the transmission (TEM) or scanning electron microscope (SEM) is gaining interest because it permits one to correlate microstructures and texture by measuring orientation differences between neighboring entities as a function of their microstructural conditions.

There are two distinct ways to measure orientations. One way is to measure the macro texture, which is to average the orientations over a large volume in a polycrystalline aggregate. The well-established techniques of X-ray or neutron diffraction are generally used for macro texture measurements. The second method is to measure the microtexture in which the orientations of individual crystals are measured. In this case, orientations and the orientation distribution can be determined unambiguously and if a map of the microstructure is available, the location of a grain can be determined and relationships with neighbors can be evaluated. Individual crystallite orientations are measured in both transmission and scanning electron microscopes using the electron back scatter diffraction (EBSD) phenomenon and are directly related to the microstructure and microtexture. It is now possible to measure orientations automatically from predetermined coordinates in the microstructure, which is known generically as orientation mapping.

Bulk Texture Measurements by the XRD method

The texture usually consists of a number of components in different proportions. The texture of a polycrystalline material is normally represented through pole figures. However, the information given by the pole figure is qualitative or at best semi quantitative in nature. Added to that, when the texture consists of a number of components, the interpretation of the pole figure becomes cumbersome. Fig.2 depicts the (111) pole figures for cold rolled and artificially aged AA7075 and AFNOR7020 alloy samples for T/2 surface which clearly shows that the deformation texture develops stronger with degree of rolling.

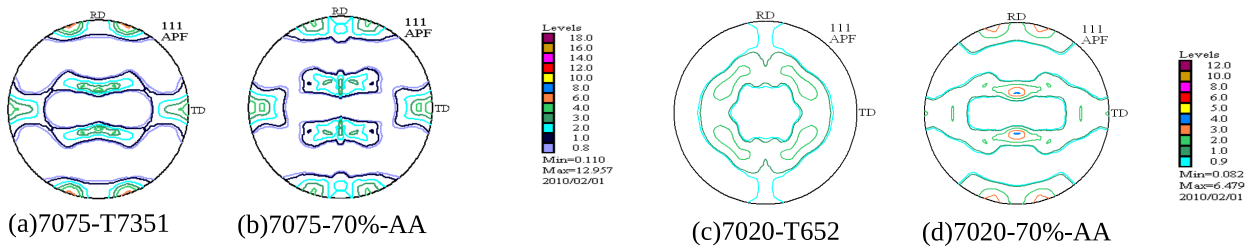


Fig 2: (111) Pole Figures for AA2219 Al alloy samples for T/2 surface

A much more comprehensive and quantitative description of texture is given by the Orientation Distribution Function (ODF). An ODF describes the frequency of occurrence of orientations in the three dimensional 'Euler' orientation space. The Euler space can be defined by the three Euler angles $\Phi_{1,}$ Φ and Φ_2. These angles constitute a scheme of three consecutive rotations which transforms the sample frames into crystal frame. Mathematical methods have been formulated to calculate ODFs from several experimentally determined pole figures. The most widely accepted methods are those developed independently by Bunge (1969), Roe (1965) and Dhams and Bunge (1986), who used generalized spherical harmonic functions to represent orientation distributions.

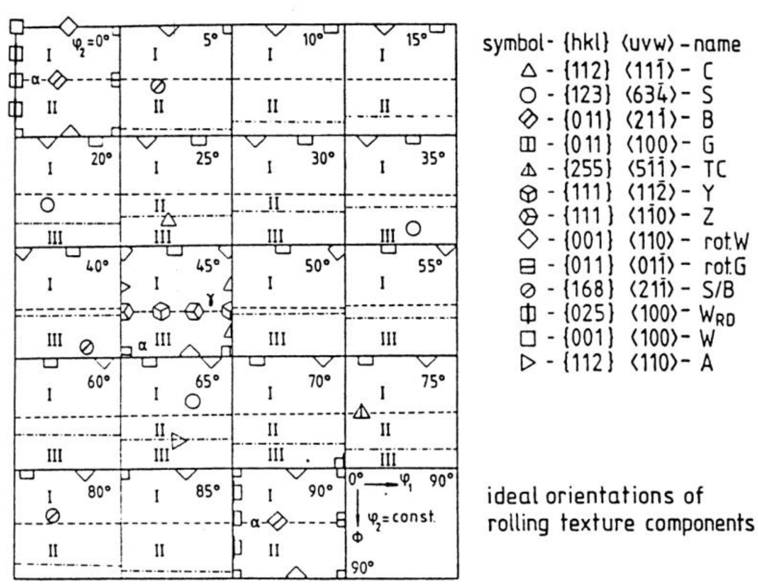
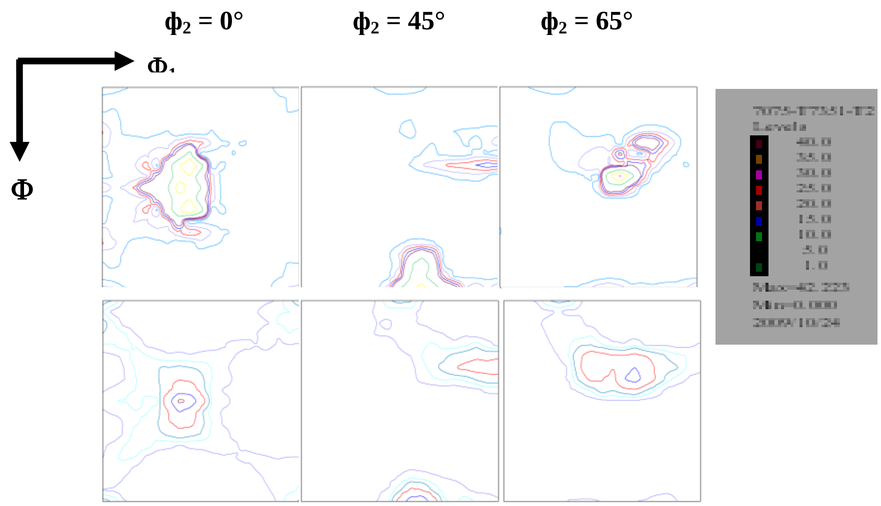


Fig 3 : Main FCC texture components in Φ_2 sections (Hirsch and Lucke,1988)

Fig. 3 indicates their positions in the corresponding Φ_2 sections. Any change in intensity or peak positions can be readily detected in a quantitative manner, when the intensity variations are plotted as a function of orientation angle in two dimensional co-ordinates. It is common practice to represent ODFs in the form of sections through the orientation space. Usually, equal distance sections along one of the Euler angles in 5 ^{o} steps are used. In general, ODFs of FCC materials are usually shown in constant Φ_2 sections. Since major texture components appear in the $\phi_2 = 0^o$, $45^o$and 65^o sections of the ODFs, comparing these ϕ_2 sections will give the overall picture. Fig 4 gives the $\phi_2 = 0^o$, $45^o$and 65^o sections of the ODFs for 70% cold rolled (a) AA 7075 and (b) AFNOR7020 alloy samples obtained from the mid thickness.



(a) AA7075

(b) AFNOR 7020

Fig 4. $\phi_2 = 0^o$, $45^o$and 65^o sections of the ODFs for 70% cold rolled (a) AA 7075 and (b) AFNOR7020 alloy samples obtained from the mid thickness

Sometimes, instead of displaying the whole ODFs, textures can be very conveniently described by plotting the orientation density along certain characteristic paths or distinct crystallographic fibers through the orientation space versus an angle which defines the position along the fiber.

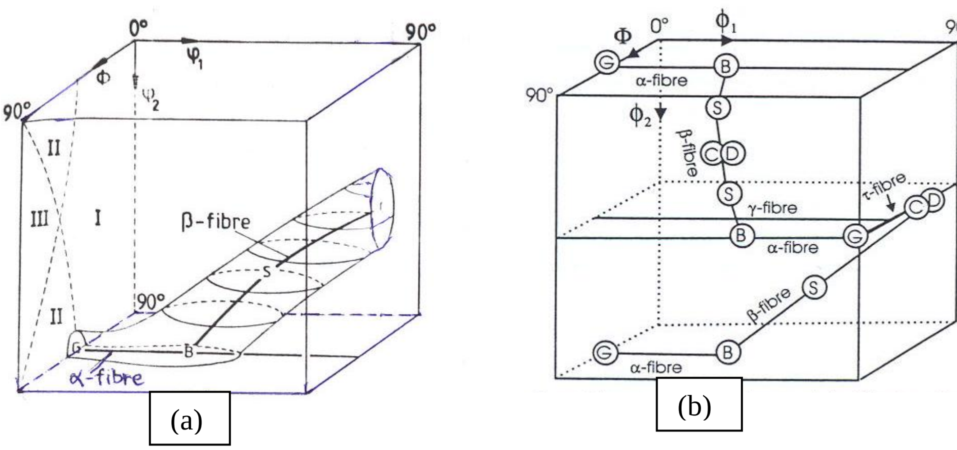


Fig 5:(a) Schematic representation of FCC rolling texture in the first subspace of the three dimensional Euler space (b) Plots of important fibers in FCC materials (Hirsch and Lucke, 1988)

In FCC materials, there are three important fibers which run through almost all the important texture components. These are an α-fibre which extends from the Goss orientation {011}<100> through the Bs orientation {011}<211> to {011}<011> ; a ζ fibre which runs from the Cu position {112}<111> and going up to the Goss orientation {011}<100> and a β- fibre which runs from the Cu position {112}<111> , through the S orientation {123}<634> and meets the α-fibre at the Bs position. Fig 5 depicts the schematic representation of FCC rolling texture in the first subspace of the three dimensional Euler space and the plots of important fibers in FCC materials.

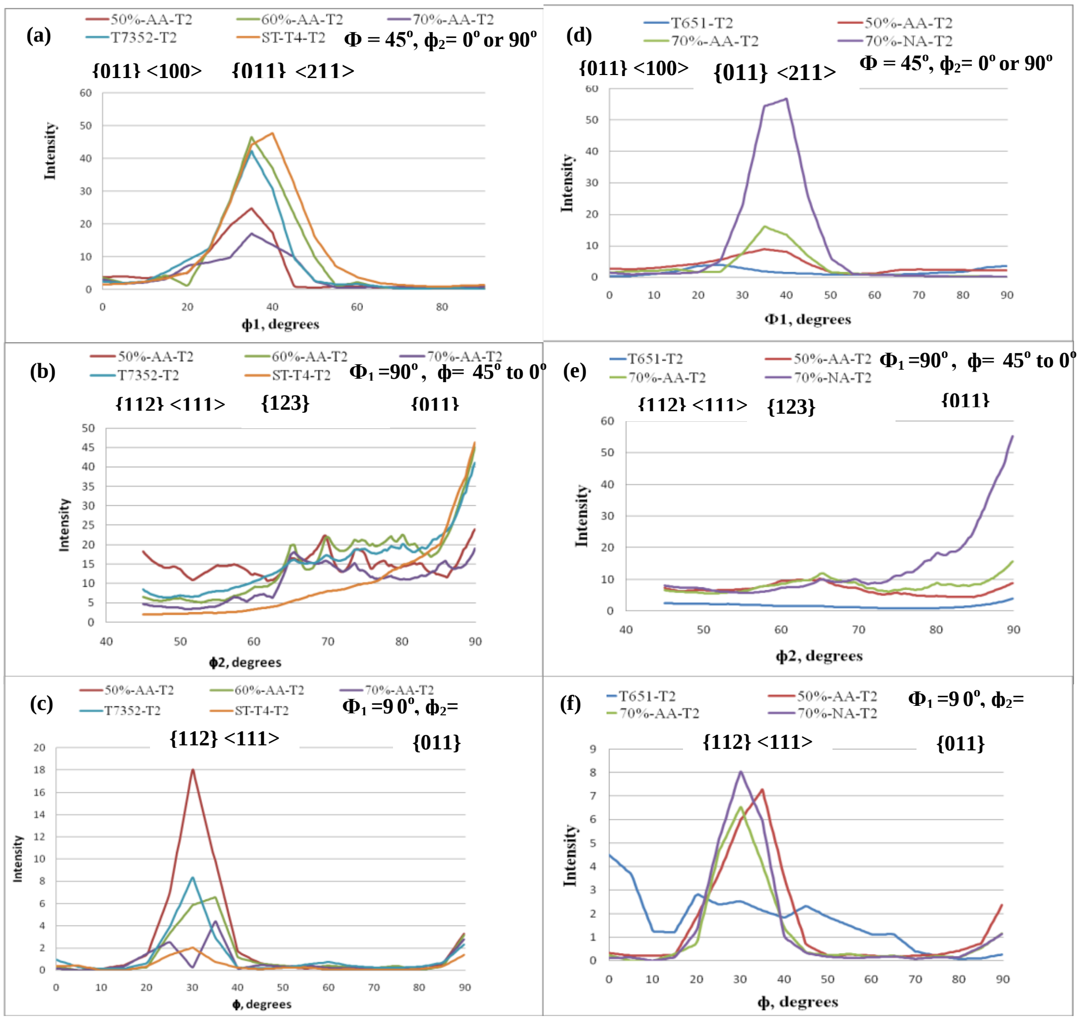


Fig.6: Fibre components in cold rolled and aged samples: (a) α, (b) β, and (c) ζ for AA7075 alloy and (d) α (e) β and (f) ζ for AFNOR7020 alloy

The α, β and ζ fibres have been plotted for the cold rolled AA7075 alloy and are given in Fig 6 (a-c). A close observation of the α and β fibres indicate the weakening of Cu and Bs texture components with increase in the cold rolling reduction. The Goss component, is homogeneous and shows a uniform trend from both the α and ζ fibre plots. The ζ fibre plot shows that the Cu component increasing from the initial condition up to 50% cold reduction and then decreases as the as the cold rolling increases to 70%. The Bs texture component shows inhomogeneity. The S component, on the other hand, increases with the amount of cold rolling. Analysis of the fibres for AFNOR7020 alloy , as shown in Fig 6 (d-f), indicate that the Bs component shows a drastic increase contrary to Cu, S and Goss components with deformation.

Texture gradient measurements in cold rolled 2219 aluminum alloy samples

The heterogeneity of texture (i.e. texture gradient) was investigated from the surface to the centre of the rolled sheets by measuring texture at the top surface (T) , at 1/4th of the thickness (T/4) and at the mid thickness (T/2) of the sheet. Fig.7 gives the ODF sections namely $\phi_2 = 0^o$, $45^o$and 65^o for the starting material in solution treated and naturally aged condition. The strength of all these texture components increases from the top surface to the mid thickness.

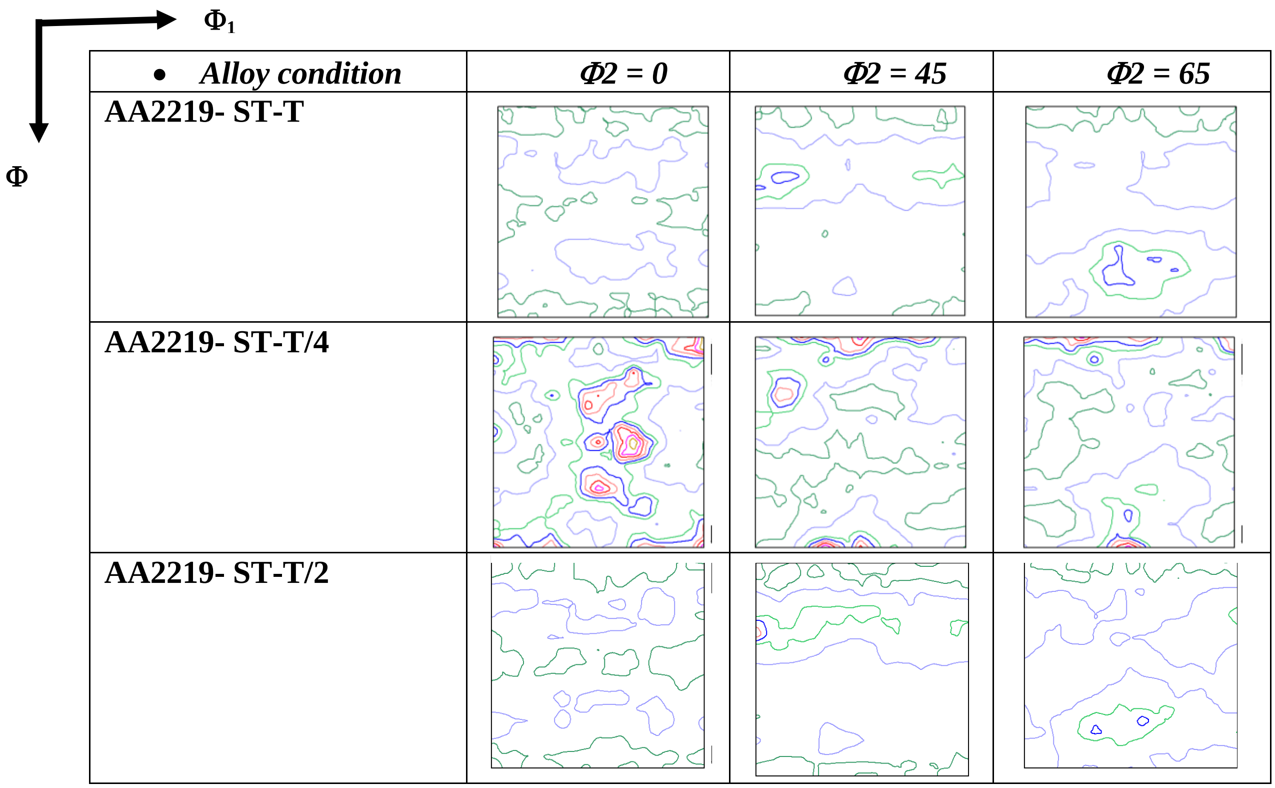
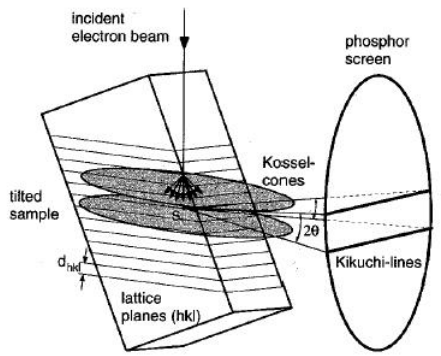


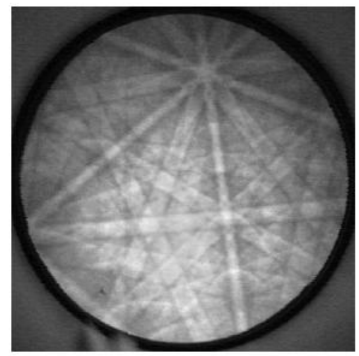
Fig .7: $\phi_2 = 0^o$, $45^o$and 65^o sections of the ODFs for AA2219 alloy ST gradient samples

Microtexture Measurements by Electron Back Scattered Diffraction (EBSD)

Local orientations can be measured with the help of SEM and this technique is becoming very popular because automated and large area scan is possible. It does not either require much background in texture theory from the user or complex sample preparation (Randle and Engler, 2000). In recent times, a big advance came with the automation of pattern indexing and scanning a specimen surface (Adams et al. 1993). The sample is translated using a high precision mechanical stage movement or sample locations are reached by beam deflection in increments as small as 1µm. At each position an EBSP is recorded using a phosphor screen, where the back-scattered electrons are converted to light and this signal is transferred into a camera. The digital EBSP is then entered into a computer and indexed automatically using the already stored library patterns for the material being scanned. The electron back-scatter diffraction (EBSD) technique was developed by Dingley (1984 a,b, 1988) and Hjelen and Nes, 1990). A complete and quantitative representation of the sample microstructure can be established with EBSD along with the overall orientation information from the sampled volume (Humpherys, 2001).



Diffraction pattern by backscattered electron



Diffraction Pattern : Bright Bands

Fig.8: Origin of Kikuchi lines from the EBSD setup in the SEM (Randle and Engler, 2000)

The basic principle of microstructural measurement through automated EBSD is based on collecting a large number of Kikuchi patterns from individual points in a selected region of a sample and determining the orientations from each of these Kikuchi patterns. When the phosphor screen of the EBSD camera intercepts the diffraction cones, a pair of general conic sections result known as Kossel cones, which are so straight that they appear to be parallel lines. These are the Kikuchi lines and a pair of Kikuchi lines form a Kikuchi band (Fig.8).

Orientation Imaging Microscope (OIM) refers to "micro"-texture measurement technique based on electron backscatter diffraction (EBSD) in the scanning electron microscope (SEM). OIM not only allows the texture to be measured, but also enables the spatial distribution of texture or microtexture to be characterized as well. Fully automated texture analysis using the EBSD in the SEM requires unattended pattern acquisition point by point, on a predefined raster grid across the sample surface, their indexing and storage of the orientation data (Humphreys, 2001, Doherty, et al.,1992, Adams et al.,1993) Fig.9 shows the schematic of the components of an automated EBSD system.

Because diffracted electrons escape from within only a few tens of nanometers of the specimen surface, specimen preparation for EBSD is critical to achieve good results. If material near the surface is deformed due to either prior mechanical operations like machining or rolling or due to grinding and polishing, or has any surface contaminant, oxide or reaction product layers present, then it is difficult to obtain a good EBSD pattern or its formation may be suppressed. Samples are to be prepared on the cross section side of the rolled sheets and the centre of the thickness of

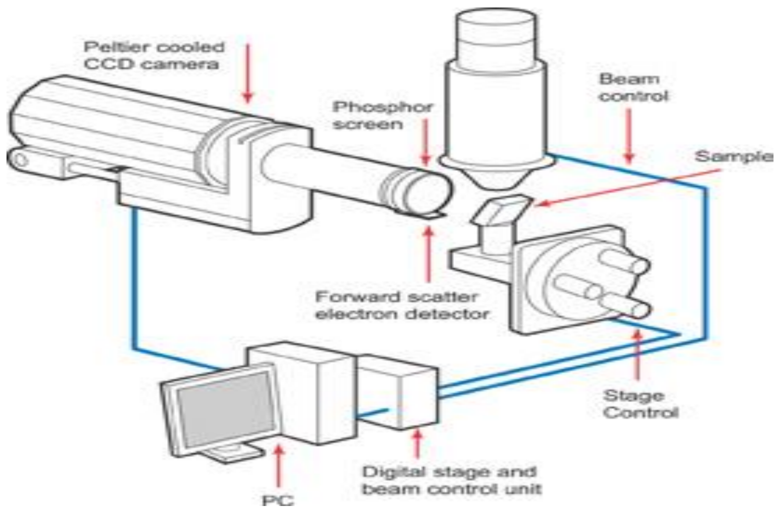
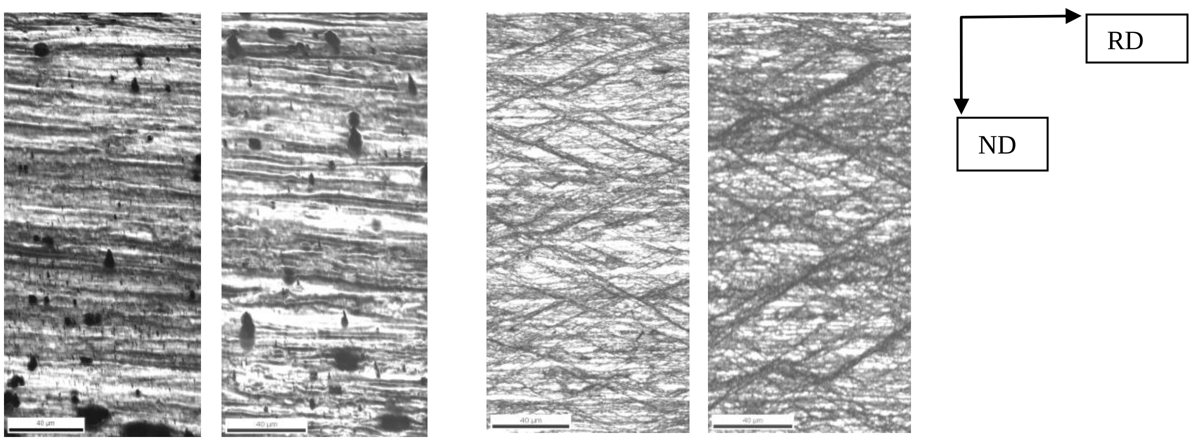


Fig 9: Schematic of the components of an automated EBSD system (Randle and Engler, 2000)

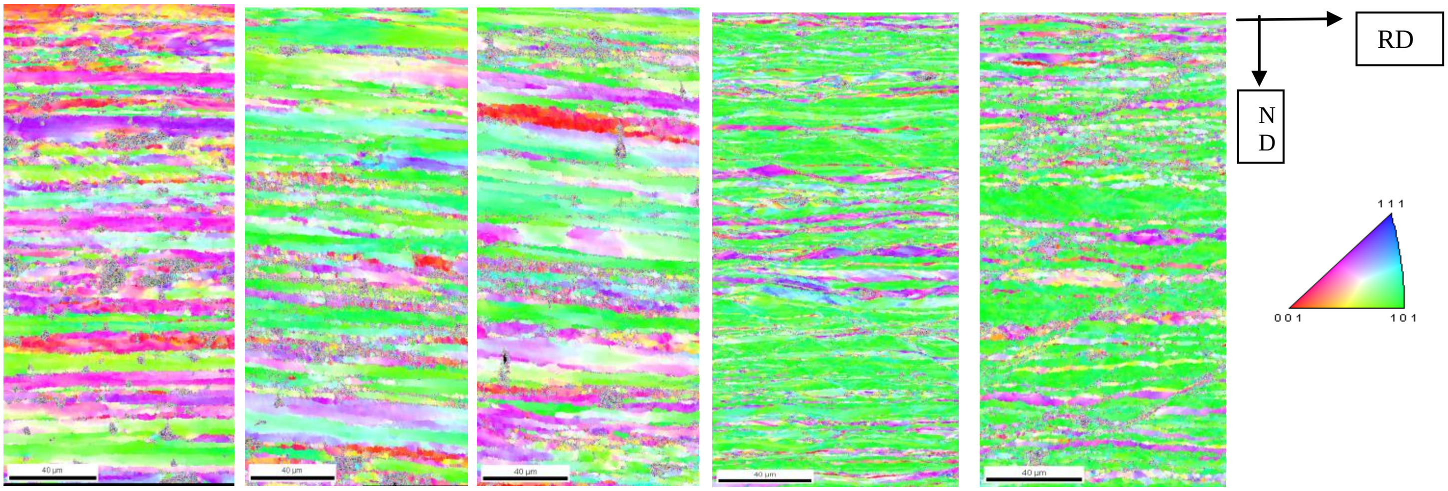
the sheets should be selected for the EBSD analysis. Inverse pole figure maps (IPFs), Image Quality (IQ) maps, Misorientation angle, Grain Orientation Spread (GOS), Kernel Average Misorientation (KAM), CSL boundaries, Grain size and Grain boundary character distribution (GBCD) are some of the prominent data that can be computed from the EBSD analysis.



(a) 7075-50%-AA-T2 (b) 7075-70%-AA-T2 (c) 7020-50%-AA-T2 (d) 7020-70%-AA-T2

Fig 10. Image Quality Maps for cold rolled samples of AA7075 alloy (a) and (b) and AFRNOR7020 alloy (c) and (d)

Image Quality Maps for cold rolled samples of AA7075 alloy (a) and (b) and AFRNOR7020 alloy (c) and (d) are given in Fig 10. The IQ maps for the 7020 alloy show shear bands and become more diffuse and darker at the regions of shear bands. Inverse pole figure (IPF) maps (TD) of the AA7075 and AFNOR7020 alloy samples subjected to different cold rolling are presented in the below figure. Each point in the measured grid is assigned code based on the orientation measured. Blue colored grains have (111) poles aligned with the sample normal whereas, the grains colored red are (100) oriented and grains in green are (110) oriented. From the color coding given in the IPF reference triangle, we can clearly see more of red and pink colored grains in the starting material which is 50% cold rolled, indicating majority of the grains are oriented in the (100) direction. As the amount of rolling is increased from 50% to 70%, proportion of the color in the IPF changes from the red to a mixture of (101) poles (green) and (111) poles (blue).This indicates that the Bs orientation {011}<211> and the Cu orientation {112}<111> contents increase whereas the Goss component decreases.



ST+50%CR+AA-T/2   ST+60%CR+AA-T/2   ST+70%CR-AA –T/2 7020 ST+70%CR-NA T/2 7020 ST+70%CR-AA T/2

Summary: Presence of texture in crystalline materials is not an exception but a rule. All crystalline materials will have texture in some form, whether weak or strong depending on the history of the processing of the material. Studying and understanding texture in materials used in various applications will help in utilizing them in a much better way. Texture evolution, which is influenced by the composition, heat treatment etc. , has a strong influence on the cracking behavior of certain alloys. The advent of sophisticated instrumentation like texture goniometer with high precision detectors, Bunge's pioneering contribution in the development of Orientation Distribution Function (ODF) and the development of Electron Backscattered Diffraction (EBSD) and the recent advancement in performing in-situ X-ray, Neutron and Synchrotron radiation based experiments have immensely helped in understanding and analyzing texture in materials.

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World's Lightest Material is a Metal, Could Be Used for Making Better Batteries

A newly invented material could revolutionize many industries at once. Discovered by a collaborating team from three U.S. universities, the metal is the lightest material ever discovered – so light it can actually sit on a dandelion. The new material's density is 0.9 milligrams/cubic centimeter, and Styrofoam, one of the lightest so far, is 100 times heavier.

The lightweight metal has been engineered at nanoscale level, so that the "micro-lattice" of interconnected hollow tubes contains 99.99 percent air, and only 0.01 percent solid. The tubes' wall thickness is 1,000 times thinner than human hair.

"Materials actually get stronger as the dimensions are reduced to the nanoscale," explained UCI mechanical and aerospace engineer Lorenzo Valdevit, UCI's principal investigator on the project. "Combine this with the possibility of tailoring the architecture of the micro-lattice and you have a unique cellular material."

The material has great mechanical properties. It recovers from compression exceeding 50 percent strain and is a very good energy absorber. One of the most important fields of interest to green technology is making better battery electrodes. The new material could be the perfect candidate, since its lightweight and extreme porosity are just the properties battery researchers are looking for right now. For example, a battery made with such electrodes could be both cheaper and store more lithium ions, hence being able to store more electrical charge.

The team included researchers from UC Irvine, HRL Laboratories and the California Institute of Technology, having Dr. Tobias Schaedler from HRL as lead author.

Ref: http://www.greenoptimistic.com/2011/11/18/world-lightest-material-metal/

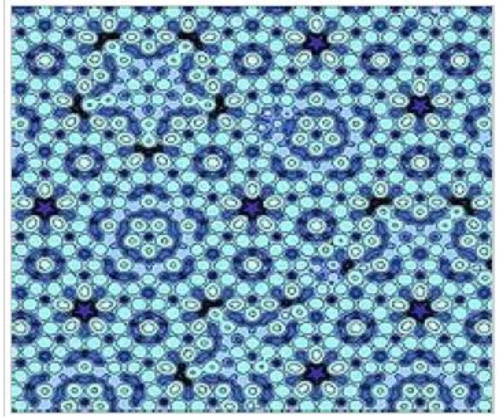
Article contributed by V.Anil Kumar, F.Gino Prakash, MME, VSSC

Nobel Prize in Chemistry for dogged work on 'impossible' quasicrystals

Dan Shechtman (born January 24, 1941 in Tel Aviv) is the Philip Tobias Professor of Materials Science at the Technion – Israel Institute of Technology, an Associate of the US Department of Energy's Ames Laboratory, and Professor of Materials Science at Iowa State University. On April 8, 1982, while on sabbatical at the U.S. National Bureau of Standards in Washington, D.C., Shechtman discovered the icosahedral phase, which opened the new field of quasiperiodic crystals. He was awarded the 2011 Nobel Prize in Chemistry for "the discovery of quasicrystals". A scientist whose work was so controversial he was ridiculed and asked to leave his research group has won the Nobel Prize in Chemistry.

He received the award for discovering seemingly impossible crystal structures in frozen gobbets of metal that resembled the beautiful patterns seen in Islamic mosaics. Images of the metals showed their atoms were arranged in a way that broke well-establised rules of how crystals formed, a finding that fundamentally altered how chemists view solid matter. In addition to the kudos of the award, Shechtman receives 10 million Swedish kronor (£934,000).

Crystallised materials are normally made up of "unit cells" of atoms that repeat over and over to make a single, uniform structure. This kind of crystal structure makes graphite a good lubricant, for example, because it can cleave easily across certain planes of weakness. On the morning of 8 April 1982, Shechtman saw something quite different while gazing at electron microscope images of a rapidly cooled metal alloy. The atoms were packed in a pattern that could not be repeated. Shechtman said to himself in Hebrew, "Eyn chaya kazo," which means "There can be no such creature." The bizarre structures are now known as "quasicrystals" and have been seen in a wide variety of materials. Their uneven structure means they do not have obvious cleavage planes, making them particularly hard. "His discovery was extremely controversial. In the course of defending his findings, he was asked to leave his research group," the Nobel committee at the Royal Swedish Academy of Sciences said in a statement. "However, his battle eventually forced scientists to reconsider their conception of the very nature of matter … Scientists are currently experimenting with using quasicrystals in different products such as frying pans and diesel engines."



Shechtman's Nobel Prize winning work was in the area of quasicrystals, ordered crystalline materials lacking repeating structures, such as this Al-Pd-Mn alloy.[7]

In an interview this year with the Israeli newspaper, Haaretz, Shechtman said: "People just laughed at me." He recalled how Linus Pauling, a colossus of science and a double Nobel laureate, mounted a frightening "crusade" against him. After telling Shechtman to go back and read a crystallography textbook, the head of his research group asked him to leave for "bringing disgrace" on the team. "I felt rejected," Shachtman said. The existence of quasicrystals, though controversial, was anticipated much earlier, but Shechtman was the first to see them in nature. The 16th century astronomer Johannes Kepler drew quasicrystal-like patterns in his book Mysterium Cosmographicum. In the 1970s, Sir Roger Penrose, the Oxford University mathematical physicist, created "aperiodic" tiling patterns that never repeated themselves, work that he suspects was inspired by Kepler's drawings.

"I once asked Shechtman if he knew about my tilings when he saw the things he saw. He said he did, but that he didn't have them in mind when he was looking at them," Penrose told the Guardian. "I think it was rather similar to my experience with Kepler's patterns. Probably he was influenced unconsciously." Penrose's own contribution to the field led some scientists to suggest he might himself be a contender for the Nobel prize. "Some people have said that, but I was a bit doubtful that would happen. Shechtman was the first person to see these things and it took a while to come around to the view that the things that were seen were the same kind of patterns I'd produced about 10 years earlier," he said. While the patterns were beautiful and fundamentally interesting, Penrose said he was not aware of any very successful commercial applications. Though quasicrystal frying pan coatings exist, he said: "I am not sure they are terribly effective. I believe they interact with egg." Astrid Graslund, professor of biophysics at Stockholm University and secretary for the Nobel Committee for Chemistry, conceded: "The practical applications are, as of now, not so many. But the material has unexpected properties. It is very strong, it has hardly any friction on the surface, it doesn't want to react with anything, [it] cannot oxidize and become rusty."

David Phillips, president of the Royal Society of Chemistry, said: "Quasicrystals are a fascinating aspect of chemical and material science – crystals that break all the rules of being a crystal at all. You can normally explain in simple terms where in a crystal each atom sits – they are very symmetrical. With quasicrystals, that symmetry is broken: there are regular patterns in the structure, but never repeating." He added: "They're quite beautiful, and have potential applications in protective alloys and coatings. The award of the Nobel Prize to Danny Shechtman is a celebration of fundamental research."

Ref: http://www.guardian.co.uk/science/2011/oct/05/nobel-prize-chemistry-wo...

Article contributed by V.Anil Kumar, MME, VSSC

Technical Lectures

The Chapter has arranged several technical lectures during the period 2011-2012, the details of which are given below.

Speaker	Topic	Date	Venue
1. Dr. Ake Jansson Scientist Thermo-Calc Software, Stockholm, SWEDEN	Applications of Thermo Calc Software for Thermodynamic Calculations	3.10. 2011	NIIST, Trivandrum
2. **Prof. M. Sundaraman** Professor University of Hyderabad	Physical Metallurgy of gamma" strengthened Ni Base alloy	08.12.2011	VSSC, Trivandrum
3. **Prof. Manfred Stamm** Professor, Liebniz Institute of Polymer Research, Dresden, Germany	The Challenge of Polymer Nanostructures at Surfaces: From Polymer Single Molecules to Switchable Brushes and Nanotemplates	2.2. 2012	NIIST, Trivandrum
4. **Prof. Mohammed Es. Souni** Professor, Institute for Materials and Surface Technology (IMST), HAW Kiel-University of Applied Sciences, Kiel, Germany	Versatile TiO_2-Ag Nanocomposites for various Applications	23.2. 2012	NIIST, Trivandrum
5. **Dr. Subrata Pradhan** Leader, SST-1 Mission & Prototype Magnets, Institute of Plasma Research (IPR), Gandhinagar	Fusion Relevant Magnets Development Initiatives in India	21.3. 2012	NIIST Trivandrum
6. **Mr Todd Bonesteel** Dynamic Systems Inc (DSI) USA	Gleeble Systems for Materials Testing and Process Simulation	13.4.2012	Windsor Rajdhani

Members Achievements 2011-2012

In the year 2011-2012, several IIM members of Trivandrum chapter have received awards in various areas. Details are given below:

1. Dr. Bhanu Pant : Metallurgist of the Year-2011, Ministry of Steel
2. Shri Niraj Nayan : Certificate of Excellence-2011, Ministry of Steel
3. Shri M. K. Karthikeyan : Yuva Anweshak, SAME
4. Dr. R.K. Gupta et al. : (Microstructure seminar-2011, 1st prize OM)
5. Dr. R. K. Gupta et al. : (Microstructure seminar-2011, 2nd prize SEM)
6. Ms. Swathi Kiranmayee et al.: (Microstructure seminar-2011, 1st prize SEM)
7. Shri Pravin et al. : (Microstructure seminar-2011, 2nd prize OM)
8. Shri Hanamant Ray et al. : ICAMPS-2012 (Second best poster paper)
9. Shri. Sudarshan Rao et al. : ICAMPS-2012 (Second best poster paper)

Members who brought laurels to IIM Trivandrum Chapter

Dr Bhanu Pant, MPCG received **the '2011 National Metallurgist of the Year'** Award from Ministry of Steel,Government of India for his significant contributions to strategic Indian Space programmes by the development of processing technology for titanium alloys, intermetallics and bimetallic components. The award carries a cash prize and scroll of honour with a citation.

Shri.Niraj Nayan, MMG was awarded **'2011 Certificate of Excellence'** for his noteworthy contributions in the development of melting and casting technology for Ti and Ni-Ti based shape memory alloys and also for development of Isothermal Heating Furnace (IHF-MkII) for Space Recovery Experiment-II to carry out materials science experiment under microgravity condition. The award carries a cash prize and a citation.

Shri.M.K.Karthikeyan received '**SAME Yuva Anweshak Award'** for the year 2011. The Society of Aerospace Manufacturing Engineers has instituted SAME awards to recognise individuals who have made outstanding/innovative contributions in the field of aerospace manufacturing. The award carried a cash prize and a citation.

Congratulations to the Award Winners!