NPTEL

NPTEL ONLINE COURSE

NPTEL Online Certification Course (NOC)

NPTEL

Theory and Practice of Non Destructive Testing

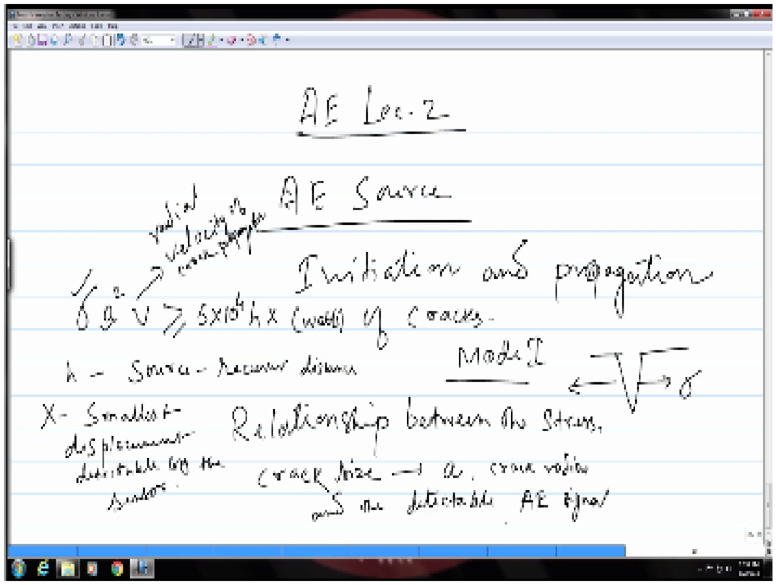
Dr. Ranjit Bauri
Dept. of Metallurgical & Materials Engineering
IIT Madras, Chennai 600 036

Acoustic Emission Testing - 2

Okay so in the last class we started this topic acoustic emission testing and we have learned about the basic principle very nice saw it is primarily due to the elastic waves elastic stress waves which are generated inside a component when it is loaded we listen to those waves which are coming out from the part through a sensor okay so when apart is loaded if you have a defect which is active for example if you have a crack of each propagates when it is loaded then it will generate these stress waves which will come out as sound waves from the sample and now if you have a sensor which can receive these waves and convert them into an electrical signal you could get a defect signal and that is how you get the indications about the defects in this particular technique okay.

And then we also saw sources of acoustic emission indifferent kind of systems and then finally we learn about the typical nature and characteristics of acoustic emission okay so in today's class we are going to see what are these source parameters what kind of system you have and how it is used to do entity okay.

(Refer Slide Time: 01:34)

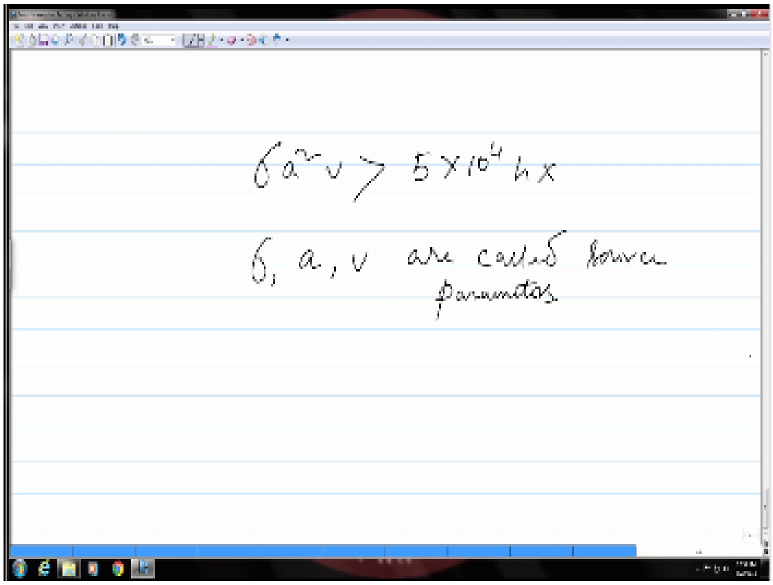


So let us first take an example of AE source in a given system and then see what are those parameters which control the aim and events in a particular system for a particular kind of defect okay let us say we are talking about this initiation and propagation of a crack so this is one of the major sources of acoustic mission as we have seen in the last class and let us say we are talking about mode one type of loading in which case you may know that if this is the crack the loading direction is perpendicular okay like this.

So in this case the relationship between the cracks eyes and the acoustic emission will be given by an equation like this so let us say this is the stress σ so the relationship between the stress and crack size let us say crack radius is a and the detectable AE signal the relationship between these three parameters will be given by this equation this will be in terms of watts so we are talking about the signal strength which depends on the stress which is being applied the size of the crack and V is the velocity of radial velocity of crack propagation.

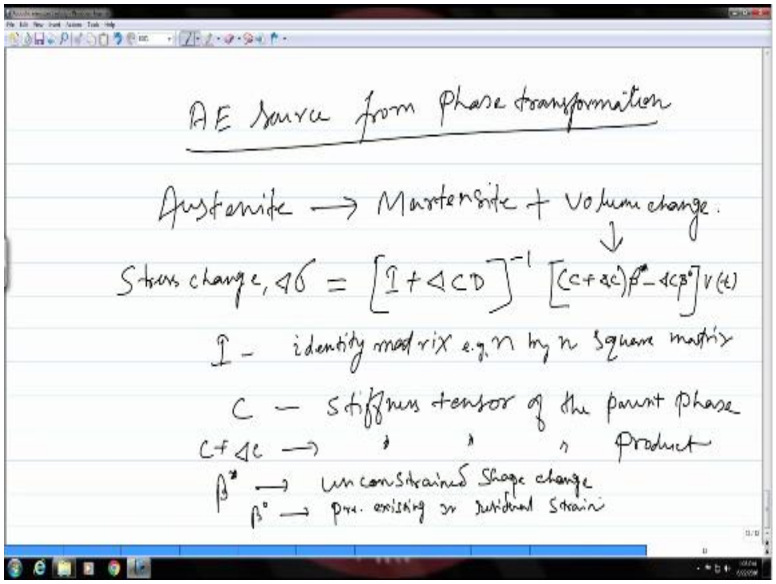
So if you remember I had said before that the crack has to propagate in order to generate acoustic emission events so this is the b is the radial velocity of crack propagation and on the right hand side do you have two parameters one is H which is the distance between the source and the receiver so this is the source to censor distance and X is the smallest displacement that the sensor can sense okay.

(Refer Slide Time: 06:05)



So these are the different parameters which control acoustic emission from crack propagation and therefore this three parameters σ a and v are called source parameters for an acoustic emission event coming out due to initiation and propagation of cracks we will take another example of acoustic event due to a different reason so let us talk about the metallic system and let us say it is a system in which you have a phase transformation okay so as I have told before this kind of events in a metallic system can also lead to stresses and due to which acoustic emission events can generate okay.

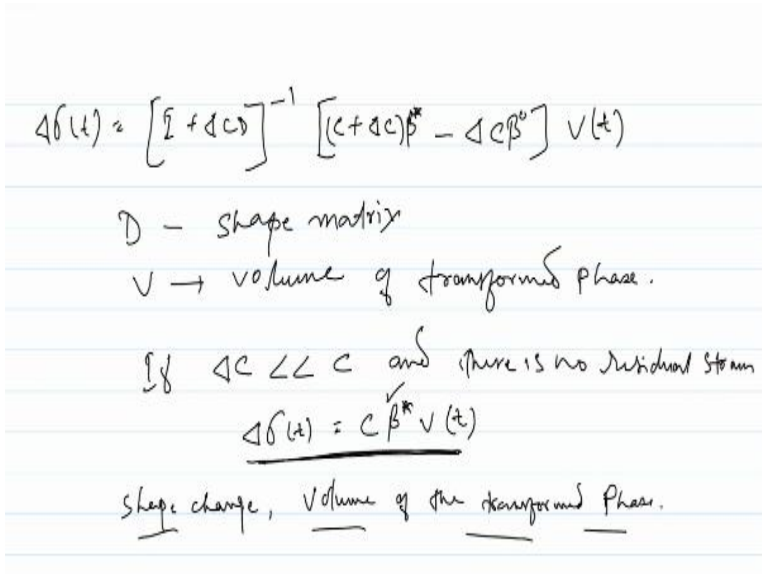
(Refer Slide Time: 07:27)



So let us talk about an AE source from phase transformation you might have heard of martensite in steals so it transforms from a high temperature phase called austenite okay when you hit it and then quench it fast in liquid like water then that high temperature phase transforms to martensite okay and these two phases are very different from each other in terms of their structure and properties and since they have different kind of structures the volume of the parent phase and the transform phase are different and due to that some stresses can be generated which may lead to acoustic emission okay so that is how it happens in this case so let us say we are talking about this particular transformation austenite to Martensite.

So as I said this will be accompanied by a volume change also okay so the stress due to this volume change if we call that as $\Delta \sigma$ will depend on these parameters let me first write it and then and I will explain these parameters so in this case I is an identity matrix for example it could be an n / n square my matrix c is the stiffness tensor of the parent phase and therefore $c + \Delta c$ is the stiffness tensor of the product phase that means Δc is the change in that stiffness due to this phase transformation from one material to another material β^* this is a parameter known as unconstrained shape change and this is the stress β_0 which could be a pre-existing stress or could be residual strength okay.

(Refer Slide Time: 12: 27)

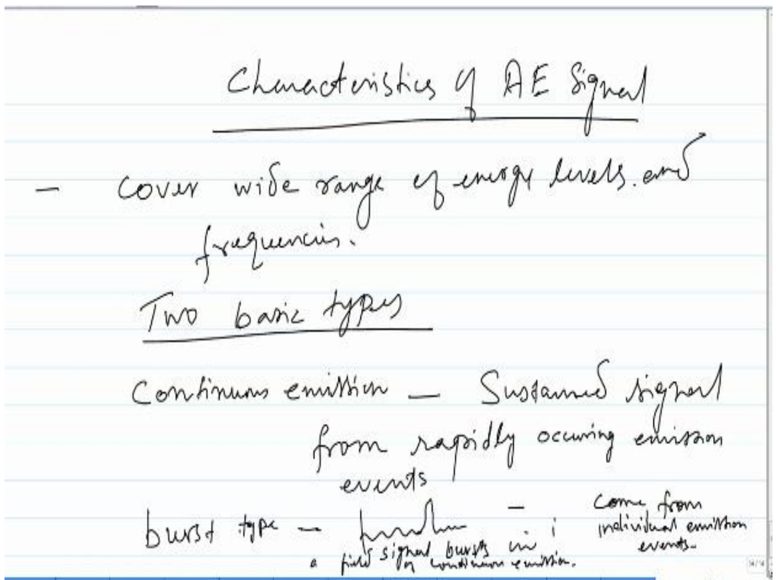


D is known as a shape matrix and v is the volume of the transform phase okay so these are the different parameters which control the acoustic emission from a from an event like phase transformation let us simplify a bit so that we can get a direct correlation between the stress which is developed due to eighth and the parameters related to the phase transformation, so if you say that the change in the stiffness Δ C is much lower than C and there is no residual strength that means β0 is zero then this will simplify to this okay.

So here you can see the change in the stress which is directly related to the intensity of the acoustic emissions which will come out due to this phase transformation event this is directly proportional to the safe change which is this so it depends on the shape change because that is what is going to introduce the stress when it will try and accommodate this change okay and it also depends on the volume of the transform phase right.

So these are the two main parameters related to the phase transformers in acid because C is a constant which is a material property as far as the phase transformation event is concerned these are the two things which will come due to that transformation one is the safe change because it is going from one material to another material and other is the volume change for the same reason okay so these two parameters will control the intensity or the level of acoustic emission from a phase transformers and event in metallic systems. So these are two examples just to let you know that you know what kind of event can lead to what kind of acoustic emission intensity.

(Refer Slide Time: 17:27)

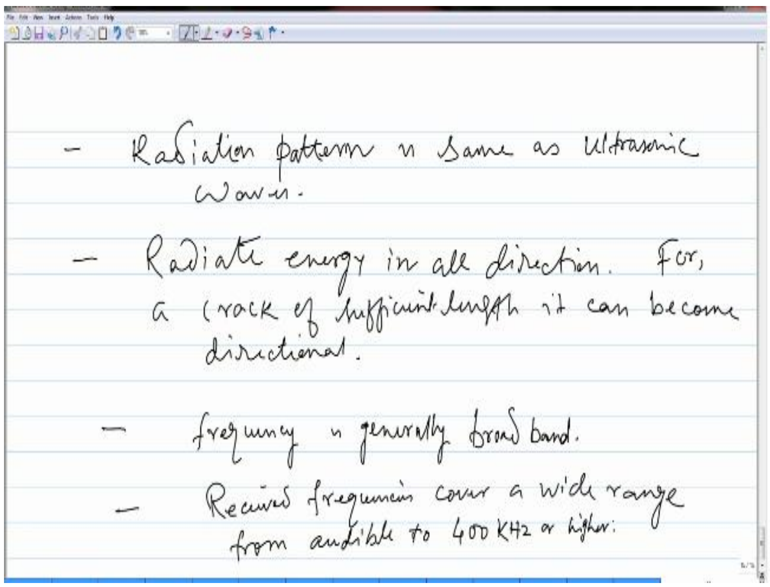


And what are those parameters which will control that intensity now we are going to talk about the characteristics of the A signal where c in the sources and some of the typical properties of acoustic emissions now if you talk about a particular signal coming out from a particular acoustic emission event then it will have certain characteristics certain properties so let us go ahead and see them okay, this kind of a signals they cover wide range of energy level depending on what kind of source you have how big is the source and so on.

And frequencies so it could have different frequencies also because these are coming out like sound waves so they will have different frequencies depending on the source and there are two basic types so this can be classified into two types one is known as continuous type so these are the signals which are sustained signal coming from rapidly occurring sources and second type is burst pipe so in this case you will see in the continuous emission waves suddenly you will see some bursts like this.

So bus type is signal burst in a field of continuous emission and this kind of signal come from individual emission events okay, so these are the two types of signals depending on what kind of source you have.

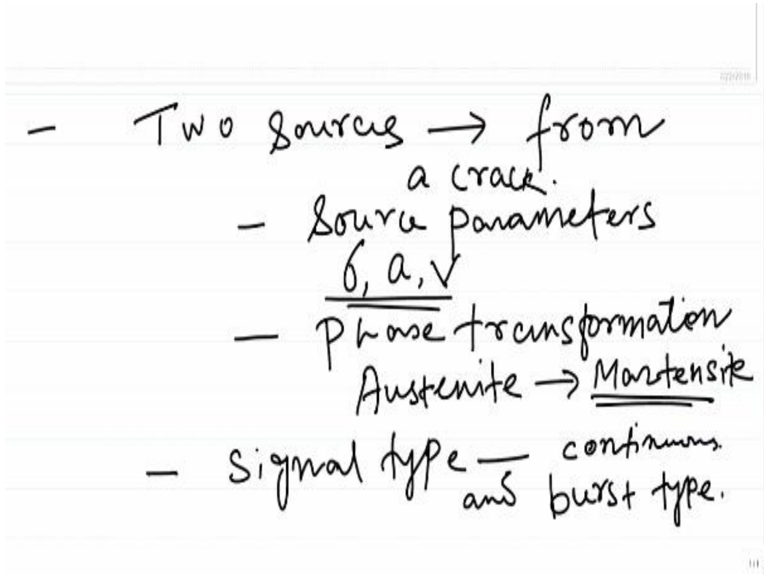
(Refer Slide Time: 21:35)



So the other properties of these emissions the radiation pattern is same as ultrasonic waves which we have talked about before and they radiate energy in all direction but some time can become directional also that means it can grow in a particular direction preferentially for example if you have the crack of sufficient length it can become direction also anyway it has its own waveform and wave pattern in which you talk about a central frequency and a variation across that frequency okay.

So you can either say it is a broadband or it is a narrowband wave depending on whether that variation about the central frequency is larger or smaller okay so acoustic emission waves that you have they are generally broad band and the received frequencies cover a wide range from audible to 400 kilo hertz or higher okay so this was about the signal properties or the characteristics of the signal coming out from acoustic emission events okay.

(Refer Slide Time: 25:15)

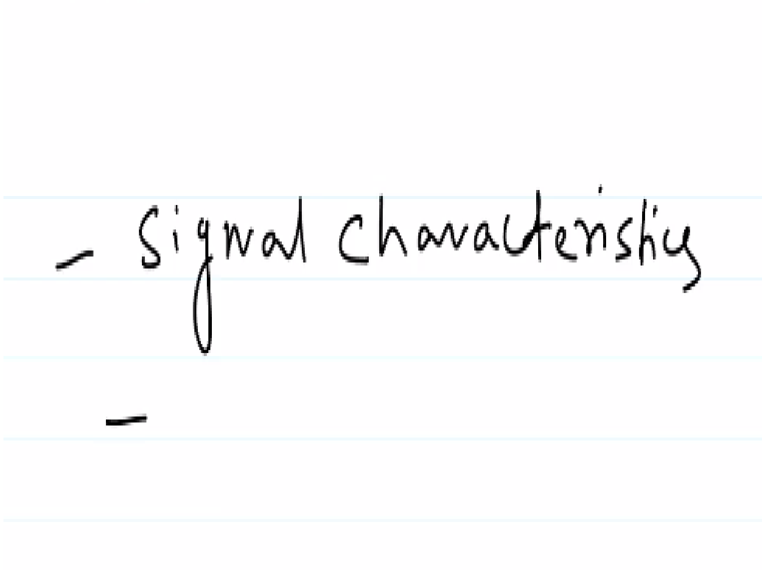


So before we close today let us take a moment to summarize today's lecture in today's lecture we saw these two sources as an example of acoustic emission source one was from a crack which is propagating and in this case we learn about this source parameters with regard to a propagating crack and these were primarily the applied stress the crack radius and the radial velocity of the crack propagation V.

And the other source that we talked about was from a phase transformation event in a metallic system and in this case we talked about this phase transformation from austenite to marten site and we saw in that case due to a change in the volume and the shape when you transform austenite to marten site due to that change there is some stress which is developed inside the material and due to that you have acoustic emissions.

Then we talked about the type of signals type of acoustic emission signals and in this we saw that there are two types of signals one is continuous and the other one is burst type so these are the two types of acoustic msn signal that generally come out from samples which are being loaded and in which you have active defects.

(Refer Slide Time: 27:54)



Then we also talked about the signal characteristics of acoustic msn signal and there we saw what is a typical nature or typical character of an acoustic emission signal which is coming out from a sample due to some dynamic events like crack propagation and all those sources that we talked about before and with that we come to the end of this class today so this is all I will have for today and the rest of the things that we have for this particular technique we are going to discuss in the next class, for today I will stop here thank you for your attention.

IIT Madras Production

Funded by
Department of Higher Education
Ministry of Human Resource Development
Government of India

www.nptel.ac.in