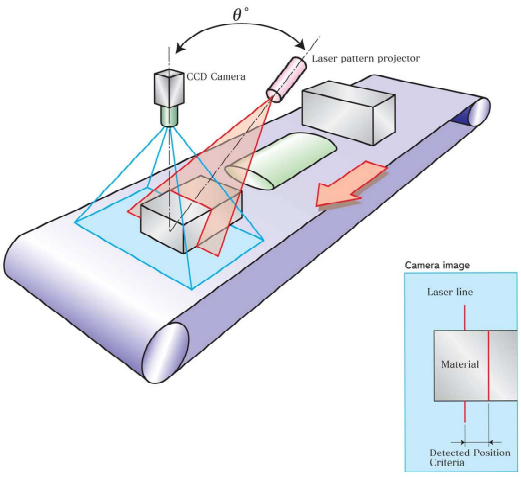
Good evening ladies and gentlemen, I am FilippoVeglia, technical leader of the NIRWiM project.

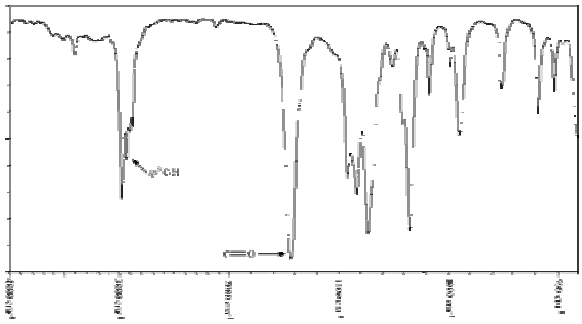
Tre Tau, the company I am representing, is an engineering company with several years history of good cooperation with Newtech, so when we were approached by them and asked to share this new research program we accepted with enthusiasm this new challenge, immediately realizing its great potential.Newtech and ourselves strongly believed in this project to the extent that we both invested for almost 3 years a significant part of our R&D resources. Now we have accomplished our task and the system is ready to be used for adding value to the magnet wire production process.

The idea to develop an in-line quality control system came up back in 2011 and the potential advantages were immediately very interesting. Clearly it was worth trying to create a tool to increase global quality, reduce scrap cost and give a feedback to actively control important production parameters.



Most of the wire qualities depend on the enamel used to insulate it and the correct enamel curing is the indispensable condition to reach the required properties. Therefore to be certain at any time that the enamel is fully polymerized gives a significant contribution to the wire quality control.

ELECTROMAGNETIC SPECTRUM



The first step was to create a conceptual design, to find the mean to read the quality of the wire without interfering in any way with the production process. It quickly came out the idea of using an electromagnetic radiation to constantly monitor the status of the enamel on the wire without touching it.
The concept was to use an electromagnetic source to irradiate the wire analyzing the reflection on a specific sensor. Finding the most suitable radiation type wasn't easy as it should be sensible enough on all types of enamel, reliable and user friendly and on top of that with reasonable hardware cost.

- FTIR
- RAMAN
- NIR

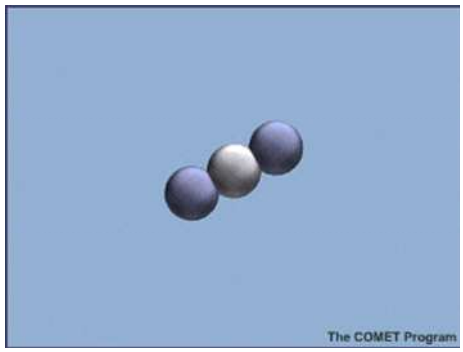
Only few types of spectroscopies can effectively analyze the polymers used in the magnet wire and are all in the IR region,specifically FTIR, RAMAN and NIR. After exploring possible solution and discussing with research centers and equipment manufacturers we realized that only NIR could be installed in every enameling line with a reasonable cost.

NEWTECH
WIRE INSULATING MACHINES

NIR (Near InfraRed) spectroscopy is based on molecular overtone and combination vibration. It makes use of the selection rules of quantum mechanics to penetrate into matter with no sample preparation.

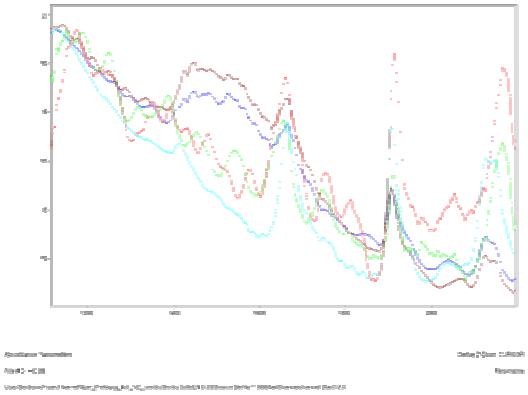
NEWTECH
WIRE INSULATING MACHINES

RESPOND TO IR RADIATION



Molecules respond to the IR radiationand give distinct peaks . The magnitude of this peaks depend on the quantity of a certain molecule. During the enameling process, as the structure of the polymer changes, some molecules are diminishing and some are increasing. If we focus on one of them, that happens to fall in the Nir range of frequency, we can then follow with a high degree of accuracy the curing process. This characteristic, together with the relatively low cost of equipment and the robustness of the spectra acquisition, made it the ideal solution for our application.

We contacted several manufacturers of NIR equipment in order to better understand if and how it would work on our application. Theoretically all the polymers used in the magnet wire enameling industry have well documented NIR interactions. But we did not know how different varnish compositions would respond to the spectroscopy. We did not know if the signal would be strong enough and if there would be significant differences between the spectra of well cured enamels and the one of non-completely polymerized ones.



The first test we managed to organize gave very encouraging results:
The enamel NIR response was strong and clear with distinct peaks. Moreover there were differences in the spectra of samples with different grades of polymerization.
Reading the wire with a spectroscopy isn't easy as the lens focus area is too big compared with enamel surface. Only very expensive equipment can go as low as 2-4 mm², which wouldn't anyway cover the whole range of wire diameters.