12-17-99

J.W.

Report of the visit of G.A.Ediss and Dr. J.Hesler (UVA) to Prof. M Afsar (Tufts)

15-16 December 1999

The purpose of the visit was to evaluate the FTS of Prof. M. Afsar with the possibility of purchasing one for the ALMA project (in collaboration with UVA).

The proposed system is specially designed for use at very long wavelengths and similar units have been used by Prof. Afsar and his staff for over 20 years to characterize materials especially in the 2-20 cm-1 region. The system consists of a polarizing Martin-Puplett interferometer with wire grid polarizers, with a Mercury arc lamp source and an Indium Antimonide detector cooled to 4K. The special modifications for use at very long wavelengths are firstly very large apertures (4.5 inches diameter) throughout the system, giving a factor of 4 improvement in sensitivity, and secondly the use of a phase modulating wobbling mirror in the moving arm part of the interferometer which gives another factor of 4 improvement. The system can make either single- or double-sided interferograms. The use of single-sided interferograms gives a factor of 2 improvement in the resolution (0.1 cm-1 compared to 0.2 cm-1) for the same number of data points but at the loss of accurate amplitude determination. Prof. Afsar uses a double mirror collimator for the source beam matching but does not use a back mirror as this was found to lead to problems with collimation and decreased performance.

The difficulties with the system are that it was designed nearly 10 years ago and uses Labview in a DOS environment. While the software is easy to use and logically designed it is primitive, only allowing 10 scans to be made automatically, which the user then has to load individually to average and then process, and only simple ratioing of the FFT results are possible. (The modulus, phase, sine and cosine transforms are available.)

The system for sale can be evacuated and has a sample moving capability, without breaking the vacuum, but to change the sample the vacuum of the whole system is lost. It does have a 4 inch travel of the moving mirror and would be supplied with lock-in, source detector and computer. One problem is that the source code is not available and the files are saved in binary form which has to be individually converted by the user.

As proof of the systems capability a similar system with 60 mm apertures and complete temperature control, using a water chiller to maintain a temperature stability of 0.1C was used to measure a 5 layer vacuum window in transmission and a piece of Goretex material. In order to characterize the window sufficiently to observe the Quartz substrate fringes a single sided interferogram with maximum resolution had to be made. 10 sample scans and 10 reference scans were made, which took 2 hours, after the system had stabilized for 1 hour. All scans were very repeatable (within a few % of each other and each scan seems to be accurate in amplitude to +/- 2%). The measured transmission with a resolution of 0.1 cm-1 is shown in figure 1, figures 2 and 3 show the MMICAD calculated transmission for 1 and 3 GHz frequency steps (0.03 cm-1 and 0.1 cm-1).

The Goretex was measured in dispersive mode to accurately determine the losses and the refractive index, shown in figures 4 and 5 respectively, and show that the permittivity of Goretex is 1.3. This capability will not be available on the system which is for sale. The Goretex measurements had to be analyzed with a second program on a different computer. This gave very believable results from 3.5 to 15 cm-1, the upper cut-off is due to the phase modulation and has

to be optimized for the wavenumber range of interest.
A further problem is that the start position of the micrometer for the moving mirror is not read-out but has to be entered manually, and the position of the micrometer is not monitored.

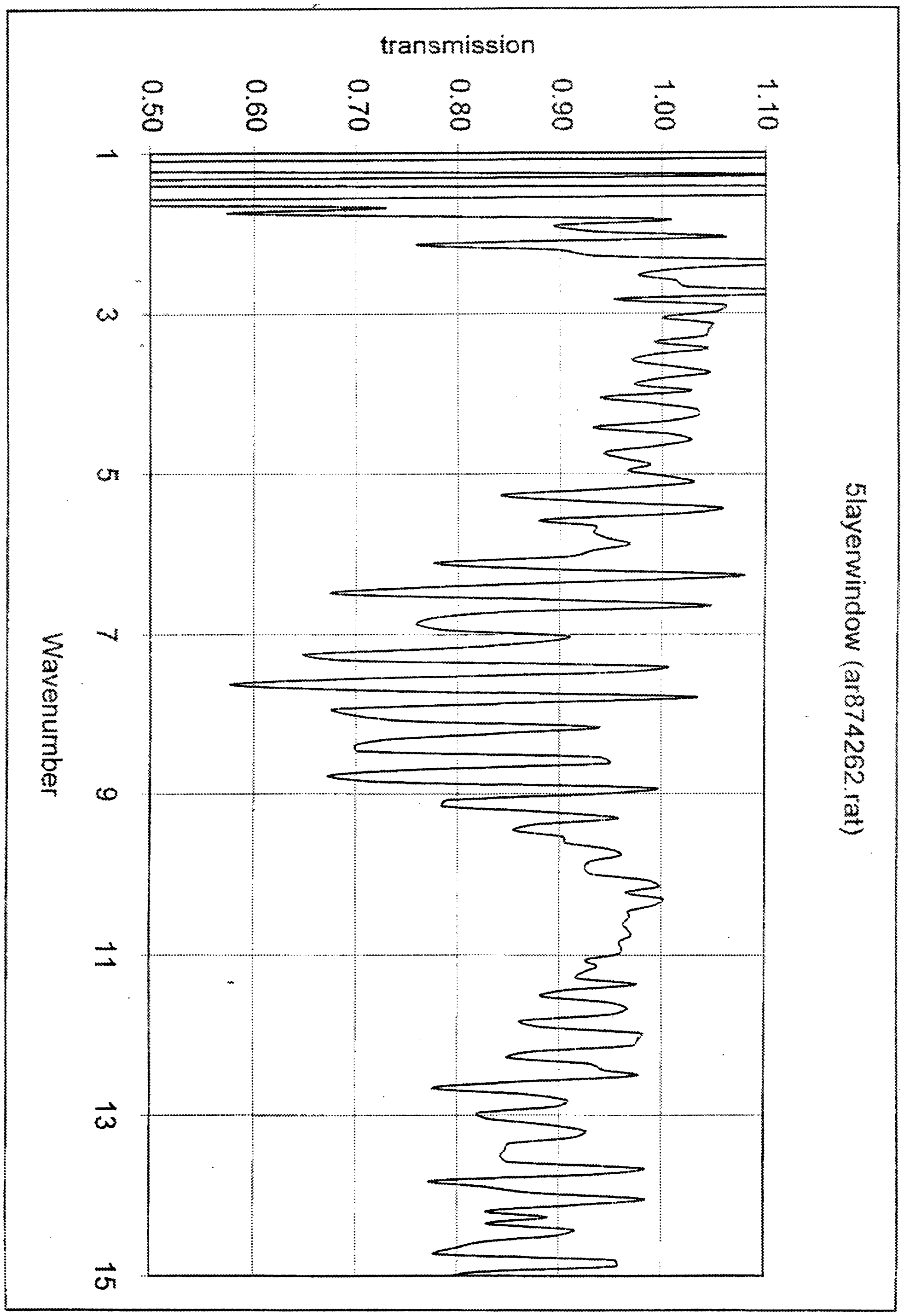

Figure 1 Measured FTS transmission

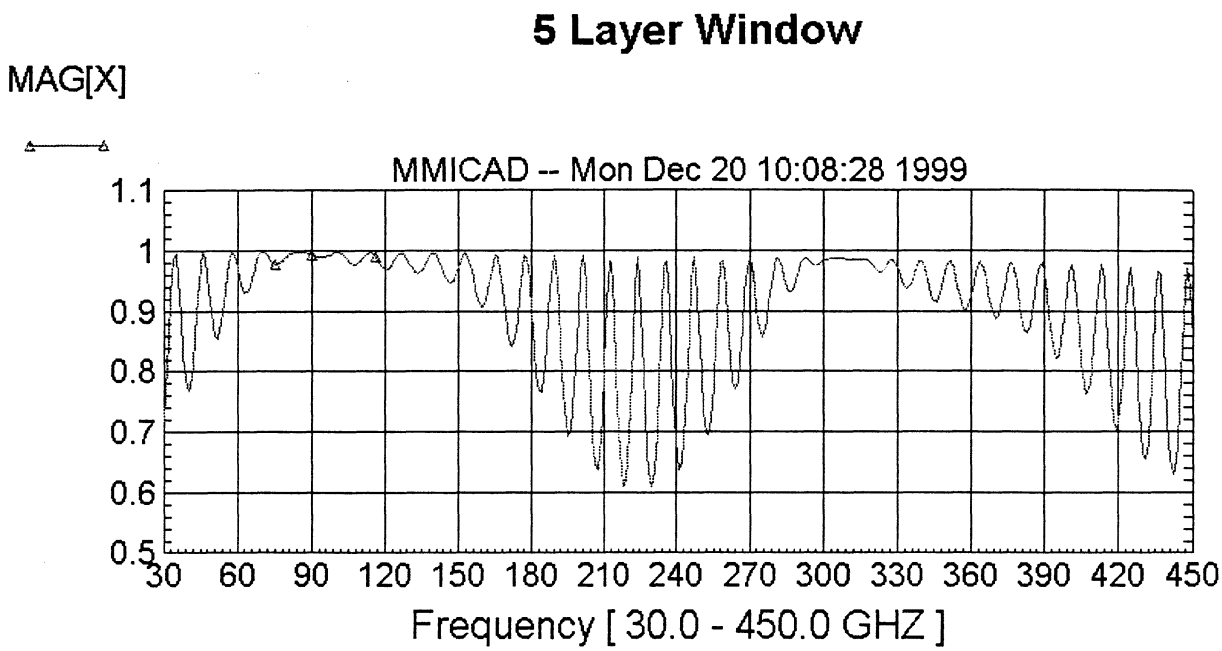

Figure 2 MMICAD calculation 0.03 cm-1 resolution

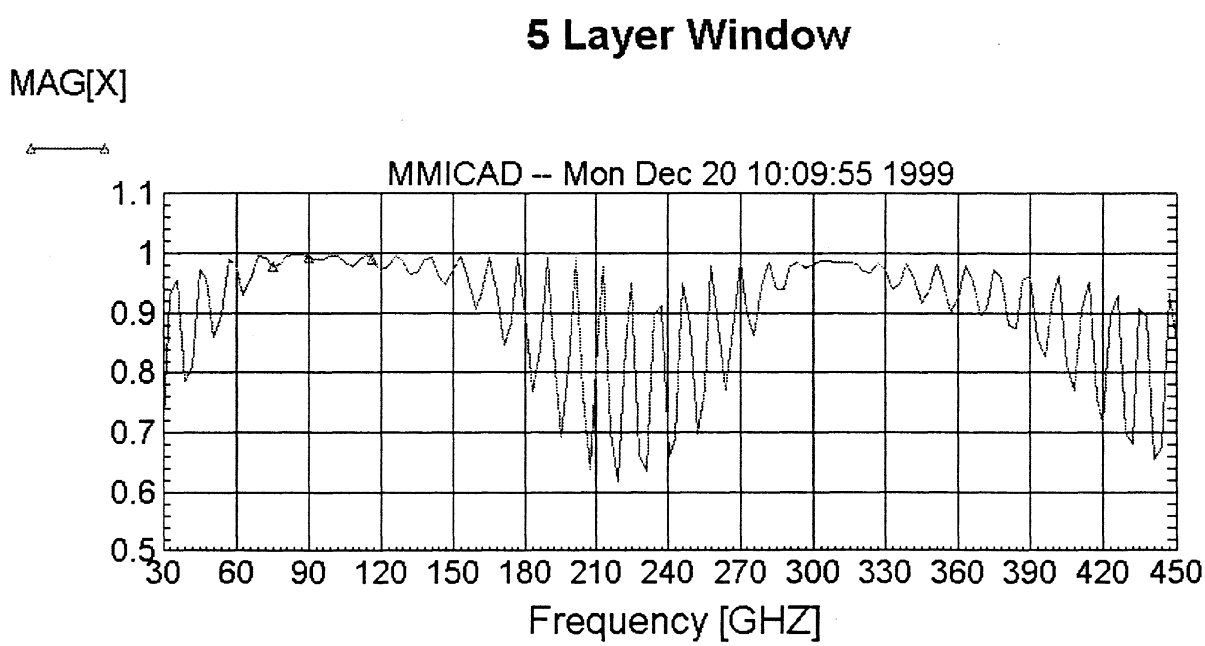

Figure 3 MMICAD calculation 0.1cm-1 resolution

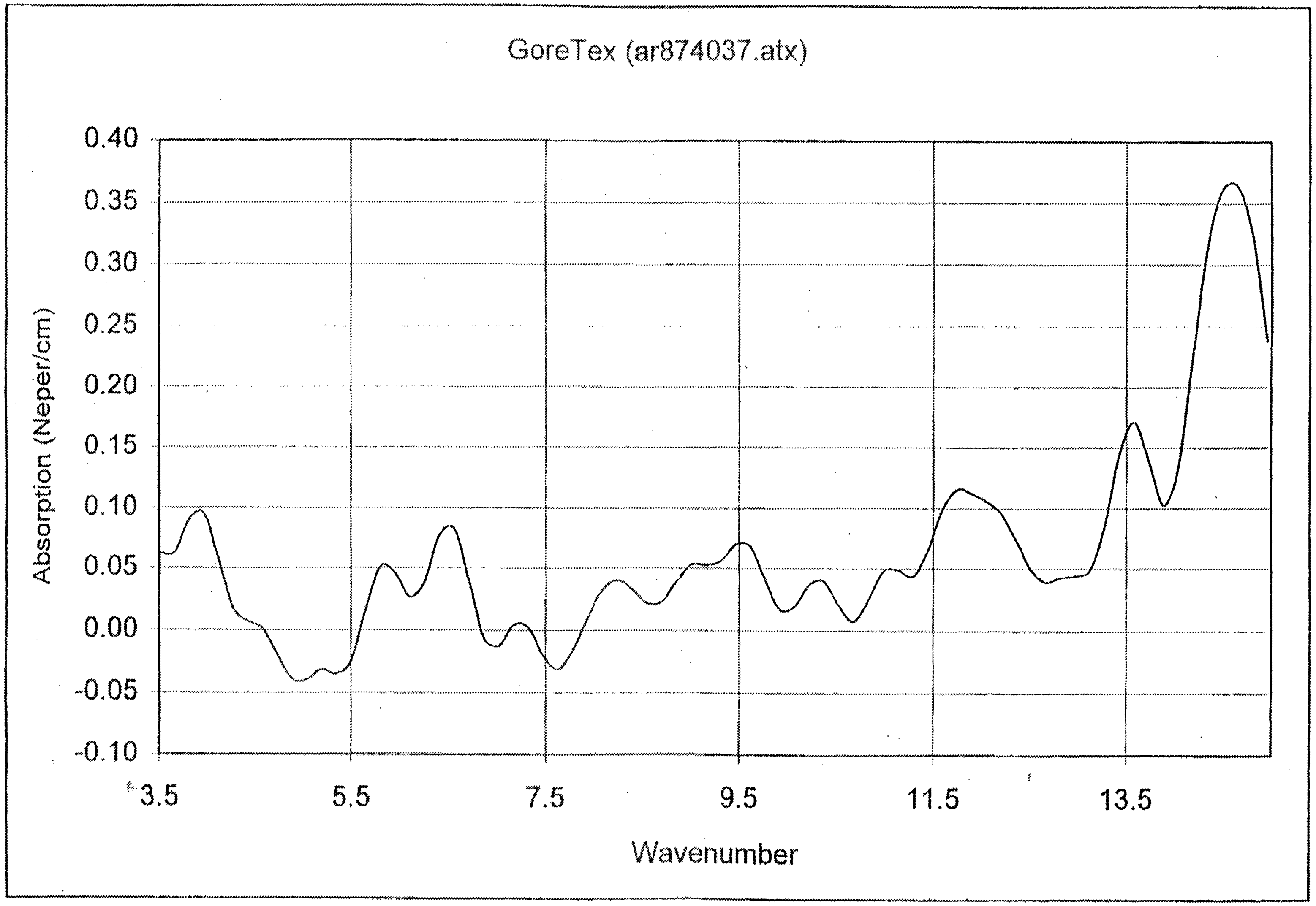

Figure 4 Dispersive FTS measurement

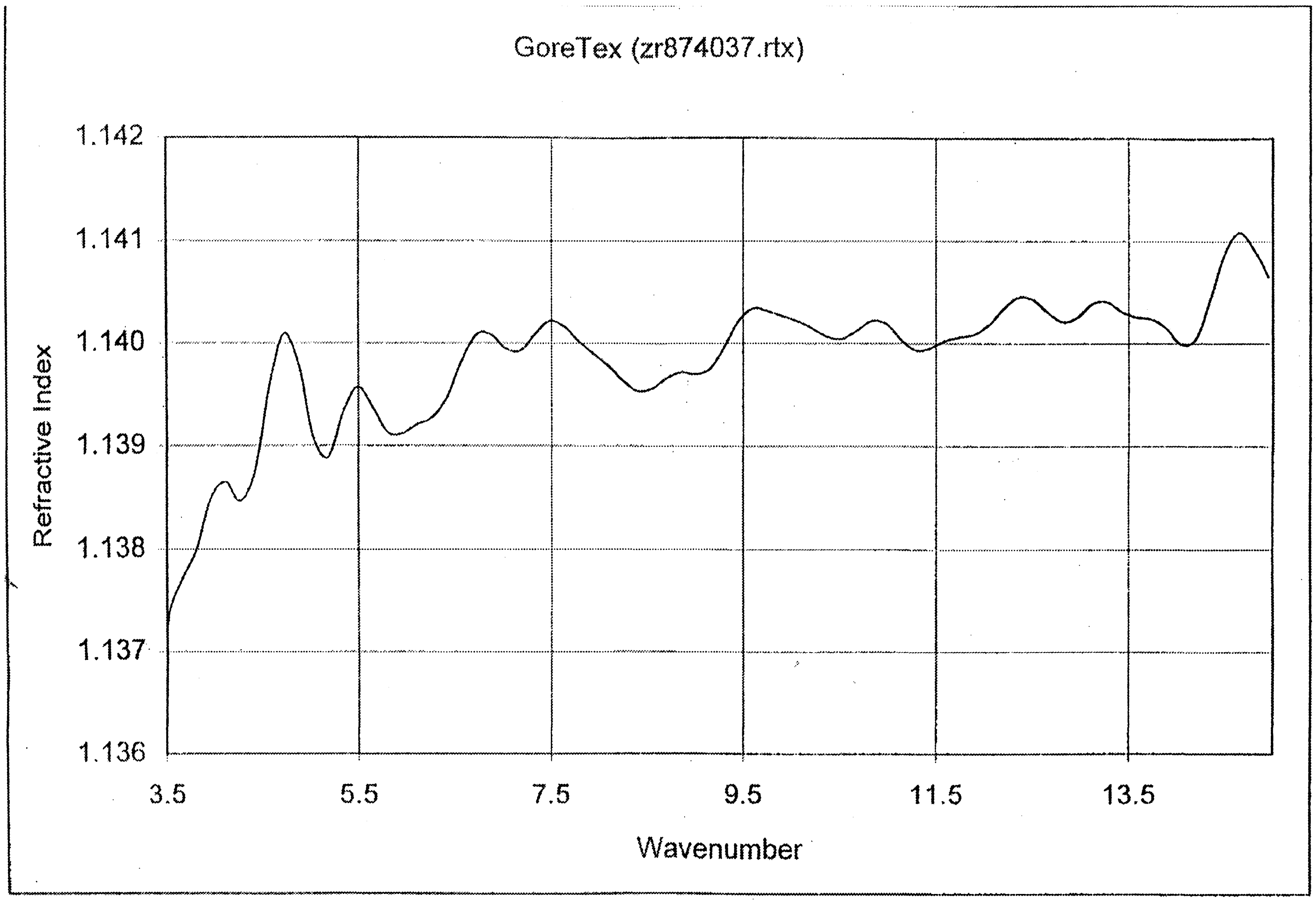

Figure 5 Dispersive FTS measurement