REPORT

on IUVSTA TECHNICAL TRAINING COURSE IN HUNGARY II., 2009 (TTC#10)

1. TITLE, LOCATION AND DATE OF ITTC

TRAINING COURSE ON PRACTICAL VACUUM TECHNIQUE

GYAKORLATI VÁKUUMTECHNIKA TANFOLYAM

held in Institute of Nuclear Research (ATOMKI)
Bem tér 18/C, 4026 Debrecen, Hungary

April 20-24, 2009

2. ORGANIZER

Organization:

Division of Vacuum Physics, Technology and Applications of Roland Eötvös Physical Society (DVPTA of REPS), Budapest, Fő u. 68, H-1027 Hungary

Responsible person:

Dr. Sándor Bohátka
President of DVPTA of REPS

3. INTENT OF THE COURSE

Teaching of vacuum technique in Hungary is available only at some universities and in big companies, but it is selected and adapted to local needs in both cases. Education and training of technicians, postgraduate students, engineers and scientists working in vacuum-related fields is the aim of this course. The participants of the course are supported by an up-to-date comprehensive teaching book on vacuum physics and -technique in Hungarian.
The course is a stand-alone one.

4. TEACHERS:

Dr. Sándor Bohátka, senior scientist, ATOMKI (Chapter 1-12, 14),
Dr. Gábor Langer, senior scientist, Solid State Physics Department of Debrecen University (Chapter 13, 14),
Dr. Dezső Varga, senior scientist, ATOMKI (Chapter 14),
Dr. Sándor Mészáros, senior scientist, ATOMKI (Chapter 14).

5. LANGUAGE: Hungarian

6. PROGRAM OF THE COURSE

Lectures: 29 hours, demonstration in laboratories: 3 hours.

1. Brief overview on the history and applications of vacuum technique
2. Fundamentals of the kinetic theory of gases
   - Model of the ideal gas

- Distribution of velocities
- Pressure
- Wall flux density
- Even distribution of energy
- Mean free path, collision rate

3. Transport phenomena
   - Diffusion
   - Internal friction in gases
   - Thermal conduction in gases
4. Interaction of gases and condensed matter
   - Possible sources of gases in a vacuum vessel
   - Vapours, evaporation, condensation
   - Sorption phenomena
   - Permeation
5. Total pressure gauges
   - Mechanical vacuum gauges
   - Viscosity vacuum gauge
   - Liquid level manometers
   - Thermal conductivity vacuum gauges
   - Ionisation vacuum gauges (hot and cold cathode types)
6. Partial pressure measurement (mass spectrometers)
   - Brief overview on the different types
   - Practical aspects, residual gas analysis
7. Leak detection methods, apparatus and practice
8. Flow of gases
   - Gas flow, pumping speed, throughput
   - Flow resistance and conductivity, effective pumping speed
9. Flow through apertures and pipes, pump-down time of the recipient
10. Pumps (with special attention to oil-sealed and dry techniques)
    - Positive displacement pumps
      1. alternating displacement pumps
      2. rotary displacement pumps
    - Fluid entrainment pumps
    - Molecular pumps
    - Sorption pumps
    - Cryopumps
11. Vacuum systems
    - Examples of real systems for different pressure ranges
    - Hints on operation
12. Technical aspects
    - Materials used in vacuum technique
    - Accessories
    - Junctions, seals, feedthroughs
    - Cleaning

13. Thin films
    - Film preparation
        1. Physical vapour deposition (evaporation, sputtering, laser ablation, MBE)
        2. Chemical vapour deposition
        3. Film formation and structure
    - Mechanical, electric, magnetic and optical properties of thin films
    - Characterization of solid surfaces and thin films (mostly by electron and ion beams)

      film thickness measurements, Electron Microscopy - SEM, TEM, Electron Spectroscopy – XPS, UPS, AES, Reflected Electron Energy-loss Spectroscopy – REELS, Elastic Peak Electron Spectroscopy – EPES, Secondary Ion/Neutral Mass Spectrometry (SIMS, SNMS), Scanning Tunnelling Microscopy (STM), X-ray diffraction), Rutherford Backscattering Spectrometry – RBS, Elastic Recoil Spectrometry – ERS, Medium-Energy Ion Scattering – MEIS, Ion Scattering Spectroscopy - ISS
    - Mechanical, electric, magnetic and optical properties of thin films

14. Laboratory practice
    - Calculation of basic quantities (pumping speed required in a system, pipe dimensions, etc).
    - Demonstration of high vacuum and ultrahigh vacuum pumps, accessories and systems; a quadrupole mass spectrometer; an electron spectrometer system; thin film production with magnetron sputtering; SIMS, SNMS; TEM, STM; X-ray diffraction.
    - Leak detection with Pirani and ionisation gauges, and mass spectrometry.

Theoretical basis of the related phenomena (chapter 1-4) have been treated in short, knowledge essential in production and laboratory practice have been discussed in detail.

Detailed program (in Hungarian) and timetable are attached.

7. ATTENDANCE

Engineers, postgraduate students, scientists and technicians working in production, research and teaching: 34 persons (***list of the participants is attached***).

8. RESULTS OF THE COURSE

This course covered the most important fields of vacuum physics and -technique as well as the methods of production and analysis of thin films. Those who attended this course have got an introduction to the theoretical basis of vacuum physics (kinetic theory of gases, transport phenomena, flow of gases, interaction of gases and condensed matter); the working principle and practical operation of all existing pumps and gauges was explained as well as how to build vacuum systems for various purposes; an overview was given on materials, components and accessories of vacuum technique, and practical cleaning methods were also advised. Calculation of the main parameters of a vacuum system completed the theoretical description. An overview was given on the

production of thin films, mechanical, electrical, magnetic and optical properties of thin films and on the analytical methods characterizing thin films. Vacuum systems, elements and accessories, methods and operating systems of electron spectrometry and mass spectrometry as well as leak detection methods were demonstrated in laboratories.

Most of the participants were engineers and physicists and a few technicians completed the audience. Some are newcomers in this field, some have contact with vacuum technique but need an updating and systematization of their knowledge. Participants are satisfied with the comprehensive material and practical advice.

Participants have got a copy of the teaching book: Vacuum Physics and Technique (in Hungarian) which was written based on the experience of teaching this subject for 16 years and the previous TTC in Hungary. The printed copies of the slides of chapter Thin Films were also given to the participants.

Additional value of the course: the individuals who work separately could make contacts.

Participants received a certificate on completing this course.

7. FINANCES

All support from IUVSTA was spent for the accommodation and travel of the participants.

Total IUVSTA financial support: 3500,- CHF = 741.055.- HUF

Support spent on the accommodation of 17 participants in Hotel Nagyerdő, Debrecen (4 nights):	676 600,- HUF
Support spent on travel of 8 participants:	69 985,- HUF
Total support:	746 585,- HUF

(The difference, 5530,- HUF was supplied by R. Eötvös Physical Society.)

Signed confirmations of 18 participants receiving IUVSTA support are attached.

8. ATTACHMENT

1. List of the program of TTC#10 (in Hungarian)
2. Timetable of TTC#10
3. List of the participants
4. Signed confirmations of 18 participants receiving IUVSTA financial support

Debrecen, June 16, 2009

The organizers and the participants are grateful to IUVSTA for the financial support and the valuable encouragement to organize this technical course.

Sándor Bohátka
Organizer of TTC#10
President of DVPTA of REPS