TEKST NR 149 1987

IN-SITU MEASUREMENTS OF THE DENSITY OF AMORPHOUS GERMANIUM PREPARED IN ULTRA HIGH VACUUM

by

Petr Viščor

(Submitted to Journal of Non-Crystalline Solids 1987)

TEKSTER fra

IMFUFA ROSKILDE UNIVERSITETSCENTER
INSTITUT FOR STUDIET AF MATEMATIK OG FYSIK SAMT DERES FUNKTIONER I UNDERVISNING, FORSKNING OG ANVENDELSER

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IMFUFA tekst nr. 149/87 26 pages ISSN 0106-6242

ABSTRACT.

Non-destructive, in-situ technique[1] has been used to determine the density of amorpheus germanium films, prepared in ultra high vacuum by slow sublimation onto heated single crystal sapphire substrates. Contrary to the previous results, a density deficit with the respect to the crystal has been observed. It is pointed out that the density deficit with respect to the crystalline phase (where such exists) is a general feature common to all bulk glasses and that it should be considered also as a characteristic structural feature of a stable state amorphous germanium. The apparent thickness dependence of the measured density is discussed in terms of a single relaxation mechanism.

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Non-destructive, in-situ technique[1] has been used to determine the density of amorphous germanium films, prepared in ultra high vacuum by slow sublimation onto heated single crystal sapphire substrates. Contrary to the previous results, a density deficit with the respect to the crystal has been observed. It is pointed out that the density deficit with respect to the crystalline phase (where such exists) is a general feature common to all bulk glasses and that it should be considered also as a characteristic structural feature of a stable state of amorphous germanium. The apparent thickness dependence of the measured density is discussed in terms of a single relaxation mechanism.

I. INTRODUCTION

An understanding of the electronic properties of amorphous semiconductors and insulators[2] requires a detailed knowledge of the structure of the investigated material, usually obtained from the diffraction experiments, using

either electrons, X-rays or neutrons. An important parameter in the analysis of the diffraction data and in the subsequent structural models is the density. While it has been known and accepted that in the proper bulk glasses (materials prepared in bulk form by quenching the melt such as chalcogenide glasses, silica etc.) a stable, glassy state is appreciably less dense than the crystalline counterpart, a lot of controversy surrounded the group IV elemental smorphous semiconductors. It has been thought that contrary to the case of glassy materials, no density deficit exists in amorphous germanium (a-Ge) and silicon, when prepared on to heated substrates[3] or when annealed to temperatures just below the crystallisation[4]. The experimental evidence so far has been rather contradictory, some results indicating no appreciable density deficit relative to the crystalline phase[3,4,5] while other observations[6] showed that amorphous semiconductors films seen to be quite less dense that their crystalline counterparts.

In the previous attempts to clarify this important point concerning the atomic structure of amorphous germanium a concept of voids (empty spaces in the amorphous matrix) was usually used in order to explain a finite density deficit in some as-deposited films and their subsequent densification upon annealing (annealing temperatures still below the crystallization temperature) up to the crystalline density. This model, if correct, would represent a situation quite different to that found in bulk glassy materials, where a stable,

disordered phase is usually characterised by a density deficit of up to 20-25% relative to the crystalline phase without invoking the existence of voids.

In order to try to understand the above mentioned contradicting results, they must be put in relation to other measured physical properties and the external factors that control them. It has been pointed out[7] that the most important parameters controlling the physical properties of amorphous germanium (but also of other thin amorphous films) are substrate temperature, evaporation rate and the cleanliness of the vacuum environment during the deposition. A classification scheme has been suggested to distinguish between films prepared on heated substrates ($T_s \geq 400$ K) using low evaporation rates (class A films) and those prepared on low temperature substrates ($T_s < 300$ K) using higher evaporation rates (> 5 Å sec^{-1}) (class B films).

While a degree of inhomogeneity has been detected in films of class B either through the direct high resolution electron microscopy[8] and/or small angle scattering[9] (a characteristic "columnar" structure on 10-40 Å length scale), no observable inhomogeneities (of size > 5-8 Å) are observed in class A films[7,8]. Since it is these films that represent a stable, disordered state of amoprhous germanium (a-Ge), which does not seem to show any changes in its physical properties (electrical and optical)[7] on annealing it has been a purpose of the present investigation to measure the density of class A films.

To avoid various systematic error sources in the usual density determination, an in-situ technique[1] has been employed to enable the measurement of the density of investigated films to be performed without ever exposing the films to ambient pressure and/or physically removing the films from the ultra high vacuum system. The results of this investigation are reported here.

II. SAMPLE PREPARATION AND EXPERIMENTAL TECHNIQUE

The experiments were performed in the ultra high vacuum (UHV) system with the base pressure of 1.10^{-10}torr after several days bake-out. High purity germanium (10^{13} electrically active impurities per cm^3) was thoroughly cleaned (1 part of HF, three parts of HNO_3), carefully rinsed in the doubly distilled water and placed in the tungsten evaporation coil (the coil was degassed under UHV conditions in the previous pump down), shown in Figure 1. Amorphous germanium films were deposited onto single crystal sapphire substrates, (substrate temperature during the evaporation was 400 K) which were secured onto a sample block, attached to a cold finger of the rotatable liquid helium cryostat. The evaporation rates of approximately 0.1 Å sec^{-1} were used and the pressure in the UHV chamber was never allowed to rise above 5.10^{-10}torr during the preparation of the films. Two quartz crystal oscillators allowed continuous monitoring of the evaporation rates.

Once the film of required thickness was deposited, the total change in the quartz oscillator resonant frequency was recorded and the cryostat was rotated so that simultaneous measurements of the optical reflectance R and transmittance T could be made. These measurements are normally used in order to determine the optical constants of investigated films as a function of incoming photon energy E, with film thickness either as a free parameter or a fixed parameter to be determined interferometrically ex-situ. For lower values of optical absorption however, the interference effects demonstrate themselves clearly also in R(E), T(E) data as alternating maxima and minima for particular values of E_{int}. Using these values ($R_{Max}(E_{int})$, $T_{min}(E_{int})$) together with the appropriate expressions for R and T in terms of the optical constants of the investigated film and of the substrate (refractive index n(E)) and the extinction coefficient k(E)) it is then possible to determine the values of $n(E_{int})$, $k(E_{int})$ and the thickness t of a given film selfconsistently in-situ. A non-destructive, in-situ technique[1] used in this work to determine the density of investigated a-Ge films utilises both the total change in the resonant frequency Δf of the quartz crystal oscillator and selfconsistently determined thickness t of the deposited film (R, T measurements). While the quantity Δf is proportional to the mass of the deposited film, the thickness t of the film, obtained through the analysis of the optical measurements is a measure of its volume. The density of the film is then proportional to the ratio of the

two quantities[1]

$$\rho = K.\frac{\Delta f}{t} \qquad (1)$$

where ρ is the density of the measured film, K is the constant of proportionality (to be determined by calibration), Δf is the total change in the resonant frequency of the quartz crystal oscillator and t is the thickness of the film. As can be seen from the equation[1], once the proportionality constant K is determined independently, a density of any unknown film can be measured non-destructively, directly and in-situ by noting the change Δf in the resonance frequency of the quartz crystal osciallator (~ mass of the film) after the deposition and the thickness t (~ volume of the film) through the analysis of the R, T-measurements. For calibration purposes however, both sides of equation[1] have to be determined independently and for this purpose the films have to be removed from the vacuum system. It was for this reason that gold films of various thicknesses were used for calibration (gold is a noble metal, which neither oxidises, nor absorbs water vapour when exposed to ambient pressure). They were deposited in the UHV - system, (in precisely the same way as a-Ge films) onto sapphire substrates, which were weighted prior to the insertion into the UHV system. After deposition, the substrates with gold films were removed from the UHV chamber and the density of the films was measured directly. The mass was measured by weighing the substrates after the deposition and subtracting the weight of uncoated substrates (Cahn 200 model electromicrobalance with resolution of

0.1 μg was used). The volume of the deposited films was determined by measuring the area (using the optical travelling microscope) and the thickness t (interferometrically). Noting also the total change Δf of the quartz crystal oscillation frequency for each gold film, it was then possible to determine the constant K in equation (1).

Results of the calibration measurements are shown in Figure 2, where measured density ρ is plotted against measured ratio $\frac{\Delta f}{t}$ for a number of gold films. The slope of the line determines the constant of proportionality K in equation (1). It was found to be equal to a value of

$$0.435 \pm 0.010$$

It should be pointed out that the precision of the density measurements is given almost entirely by the precision of weighing the gold calibration films. This is reflected in the quoted error of $\pm$ 0.01 in the constant K. The errors in Δf and t can be considered to be of the second order relative to the errors in weighing.

III. RESULTS

From five a-Ge films of different thicknesses that have been investigated, four belonged to class A and one to class B films. After each film was deposited values Δf and t in equstion (1) were determined through the noted oscillation frequency change of the quartz crystal oscillator and through the analysis of in-situ R,T measurements respectively. Using the constant K (determined through ca-

libration using gold films) the density of a given a-Ge-film was then calculated using equation (1). The results are displayed in Figure 3, where the density of the four class A films are plotted as a function of their thickness. For comparison a crystal density is also displayed. Also indicated is the density of a-Ge film of class B (room temperature substrate, higher evaporation rate of 10 Åsec^{-1} and unbaked UHV system with the background pressure in the region of 1-5 · 10^{-6}torr).

The results of the present investigation displayed in Figure 3 can be summarised in the following two points:

1) All measured a-Ge films are appreciably less dense than the crystal.
2) The measured density in class A films depends apparently on their thickness.

These two points will be now discussed in more detail in the following paragraph, where various structural models (in particular the "void" hypothesis) will be contrasted with the available experimental evidence.

IV. DISCUSSION

For thicknesses between 500 Å and 8500 Å, the measured density deficit (relative to the crystalline density) in investigated a-Ge films varied between 24% and 2%. Leaving for a moment a question of the apparent thickness dependence of the density deficit the important new result

contradicting the previous investigations[3,5,10] is that an amorphous state of germanium is characterised by a definite density deficit relative to the crystalline phase. The usual explanation of this kind of density deficit in a-Ge has been up till now the presence in the films of voids and/or void networks ("columnar" networks on the length scale of some 10-40 Å). Here it has to be pointed out however that the most of present results have been obtained on films of class A, where voids and/or void networks of sizes just mentioned are expected not to be present[10].

To check the "void" hypothesis, the thin films of the present work were also investigated by "in-situ"[7] high resolution electron microscopy. Figure 4 shows a typical bright field high resolution electron optical image of the studied films of class A. As can be seen from Figure 4, the films are homogeneous down to the "resolution limit" (smallest void or other density deficient spatial region in the amorphous matrix still giving enough contrast above the noise level[11]) of some 5-8 Å. Since, as can be seen from the results in Fig.3, it was the thinnest films that showed the largest density deficit, it can be concluded on the basis of the results represented in Fig.4 that the "void" hypothesis seems to be invalid for a-Ge films of class A. For the "void" hypothesis to be valid in the present case, one would have to postulate a large density (some 20% of the total volume) of microscopically small ($\lesssim$ 5 Å) voids to be distributed in the amorphous germanium atomic network.

A term void or a defect of this microscope size (a missing atom and/or missing bond), occurring with such a large density looses clearly its meaning and the microscopic "empty" spaces would have to be considered as an integral part of the atomic network itself. A more plausible explanation therefore seems to be that the atomic structural network of amorphous germanium is simply more opened (less dense packing of atoms than that of germanium crystal). This is in accordance with similar observations and conclusions coming from the investigations of bulk, glassy semiconductors and insulators such as chalcogenuide glasses, silica and others.

Dismissing the "void" hypothesis for class A amorphous germanium films does not mean that it may not be valid for class B a-Ge films. A part of the measured (see Fig.3) large density deficit (some 24%) relative to crystalline density) may be due to the columnar network seen in this type of films using electron microscopy[8]. However, due to lack of direct correlations between electron microscopy studies[8] and those of small angle scattering[4] a definite conclusion about the possible effect of the inhomogeneous nature of class B a-Ge films on the overall density can not be made at present and a more systematic and detailed investigation combining both techniques is clearly needed. It should be mentioned at this point also that a simple calculation shows that in order to account for a large density deficit in class B a-Ge films (~ 24%) through the columnar network visualised as a three-dimensional network of tu-

bular columns (assuming no atoms in them) is not sufficient. In order to obtain an agreement between the inhomogeneous model (void hypothesis) and the overall density measurements, the columnar network structures seen in the electron microscope would have to be considered as two-dimensional projection (in the kinematic approximation to the contrast formation from a disordered film) of "grain - boundary"-like low density regions connecting the high density amorphous "grain"- like spatial regions (of some 40 Å in diameter).

The present results indicate therefore that while it is possible that the inhomogeneous nature of class B a-Ge films may play some role in determining both the overall density and the density change (densification) through the structural relaxation on annealing (annealing out of the "void" network), it is the underlying amorphous matrix itself that is characterised by an open atomic structural network with overall density below that of a crystal.

One more point seems worthwhile mentioning in this context. It is a qualitatively different correlation that exists between the annealing behaviour (as seen through the d.c. electrical conductivity and the optical absorption measurements) in class A and B films. The d.c.electrical conductivity $\sigma_{d.c.}$ decreases by orders of magnitude ("parallel shifts" of the log $\sigma_{d.c.}$ versus temperature $T^{-1/4}$) and the optical absorption edge shifts to higher energies ("sharpening" of the optical absorption edge). The important point to note is that both these shifts tend to bring the $\sigma_{d.c.}$ and the optical absorption coefficient α to values cha-

racteristic of class A films. Further annealing at higher temperatures however does not lead to any further changes in these two quantities indicating the stabilisation of the system (at least as seen through the d.c.electrical and optical measurements). It seems therefore logical to conclude that class A films seem to represent a "final, glassy" state of a-Ge into which various class B films tend to anneal.

V. THE THICKNESS DEPENDENCE OF THE DENSITY

A new and unexpected result apparent in Figure 3 is that there seems to be an apparent correlation between the measured density and the thickness of the investigated films of class A. The one film of class B investigated in the present work clearly does not follow this correlation. Also outside lies 1100 Å thick film of class A. The explanation of this apparent correlation based on the effect of the substrate on the overall density of the investigated films is quite unlikely in view of the fact that most properties of solids and amorphous materials in particular seem to be determined by short range effective one-electron interactions. Effects of the substrate which would be felt up to the thicknesses of a micron must be therefore dismissed. A more plausible explanation must be the one based on some structural relaxation model. Bearing in mind that all class A films investigated in the present work were deposited at 400 K and they were held at 400 K only during the deposition for a known length of time, it is then possible to replot the Figure 3

into a plot of the measured density as a function of annealing (deposition) time. This has been done in Figure 5 and it can be seen straight away that all four films of class A investigated in the present work are now lying on a simple curve.

Using a single relaxation time model for the density relaxation of a given film in a form

$$\rho = \rho_o - \beta_s e^{-t/\tau} \qquad (2)$$

(ρ_o is the final, relaxed density; β_s is short time density deficit and τ it the relaxation time),
and taking into account the fact, that the various parts of the film stay at deposition temperature for different lengths of time during the film preparation, the expression for the density of the film after the deposition time t_{dep} reads

$$\rho = \rho_o - \beta_s \left(\frac{1-e^{-t_{dep}/\sigma}}{t_{dep}/\tau}\right) , \qquad (3)$$

where the relaxation time τ is defined as

$$\tau = \frac{1}{\omega_o} e^{\Delta E/kT} \qquad (4)$$

Here ω_o is the optical phonon frequency and ΔE is the activation energy of the process responsible for the relaxation of the film density

Although the density measurements were only of a qualitative nature (a relatively small number of thicknesses measured) a rather unambiguous fit to the data in terms of a simply activated relaxation process was possible, leading

to values of $\rho_o = 5{,}30\ g \cdot cm^{-3}$, $\beta_s = 1{,}32 g \cdot cm^{-3}$ and $\Delta E = 1{,}43$ eV in equation two. Fitting the equation three to the data in Figure 4 gave similar values for the fitting parameters. In particular, the activation energy ΔE was found to be almost unchanged ($\Delta E \sim 1{,}41$ eV). Both fits are shown in Fig.4 together with the predicted relaxation curve for samples prepared and/or annealed at room temperature.

As can be seen from Fig.4, the mass density relaxation process seen in films of class A when prepared at 400 K is completely frozen out at room temperature (relaxation time of the order of 500 years). It is now clear why the film of class B studied in the present work yielded a large density deficit which did not relax during the entire length of the experiment (some three weeks).

The simple relaxation process with a simply activated single relaxation time which seems to explain all the data presented in Fig.4 supports the notion that the densification process seen in a-Ge above room temperature involves relatively high, single activation energy, comparable in magnitude to the Ge-Ge sp_3 bond strength ($\sim 1{,}74$ eV).

Due to the qualitative nature of the results it is not possible at present to make definite statement about the final, fully relaxed density of a-Ge films. Indication is however that the final density deficit lies between one and three percent relative to crystal. It has to be stressed that at no point during the investigation of class A films has any degree of crystallinity been de-

tected either through d.c.electrical transport, Raman measurements or direct electron diffraction and/or electron microscopy. The data on both class A (high deposition temperature) and class B (room temperature deposition) films indicate also that unannealed (short time) density of a-Ge is some 24-28% smaller than the Ge-crystalline density. If the proposed simple model for the density relaxation in a-Ge (equations (2), (3) and (4)) is valid generally (the density of a given film given by its temperature/time history) regardless the way of preparation and the vacuum conditions (giving the levels of impurity concentrations), it should be then possible to plot all the observed a-Ge densities published in the literature onto the appropriate temperature/time relaxation curves in Fig.5. All the available experimental data[6] lie indeed in the density interval between 3.9 and 5.2 $g.cm^{-3}$ predicted by the present model. For the deposition temperatures at and around 300 K (time scales unimportant) the agreement between the observed values and those predicted by the model is very good (see Fig.5) despite a certain degree of scatter[3,4] (the density deficit measured was found to be only 10-15% as compared to predicted 25%; here the possibility of an increased substrate temperature and therefore an increased degree of density relaxation during the deposition has to be further clarified).

The other two measurements[5,10] employ a more indirect method to measure the density (X-ray linear absorption coefficient measurements) and will not be discussed here althrough

even here the measured densities (the density deficit of some 2-5%) fall within the bounds given by the present model. It should be also mentioned that the deposition temperature in ref.5 was 77 K and therefore a different starting density and the subsequent density relaxational behaviour might be expected (point to be discussed later). It is believed that due to atomic immobility at 77 K, the formed initial atomic structure could be viewed as a more tightly packed network of molecular-like structural units[12] (reflecting the tendency to form a molecular-like solid at these temperatures). However it is clear that much more detailed quantitative data is needed here. The expriments should involve simultaneous measurements of the density (through in-situ structural investigations) and other physical properties (d.c. and the a.c.electrical transport in particular).

Having established the density dependence of the investigated films on the deposition and/or annealing time and temperature, a correlation should be now made with other measured physical properties and in particular with the d.c.-electrical transport and optical measurements.

Here, contrary to expectations no changes in the d.c.-electrical conductivity were observed in any of four measured films of class A (absolute value of the conductivity $\sigma_{D.C.}$ and its temperature dependence was found to be the same - within the experimental error - in all four films of class A shown in Figure 5) although the density in these films varied between 23 and 2 percent. This is a very im-

portant result indicating that the electrical transport measurements seem to be unaffected by the density changes in class A films. The measured class B film on the other hand showed the conductivity some three orders of magnitude larger than in the films of class A in accordance with the general behaviour of class B films[13]. As mentioned previously the conductivity in class B films decreases on annealing towards the values characteristic of class A films ("paralel shifts" of the log of the d.c.electrical conductivity $\sigma_{d.c.}$ versus temperature $T^{-1/4}$). It seems thereforelikely that another relaxation process (more directly related to the $\sigma_{d.c.}$) is responsible for this behaviour. In this context it is worthwhile mentioning that the studies of the annealing behaviour of the $\sigma_{d.c.}$ in a-Ge films deposited on substrates held at temperatures between 77 and 300 K during the deposition[14] show that a simple relaxation model involving a single relaxation time τ (a single activation energy ΔE in eq. (4)) is not sufficient to explain the experimental observations. A relaxation model was proposed which is based on a Boltzmann-like exponential distribution of the activation energies. This model is then capable of explaining the relaxational behaviour of the d.c.electrical conductivity $\sigma_{d.c.}$ involving a wide range of substrate temperatures, annealing temperatures and annealing times.

Turning now to optical properties these were also investigated by in-situ optical relfectance R(E) and transmittance T(E) at normal incidence as a function af photon ener-

gy E. Here it was found out that the onset of the optical absorption (optical absorption edge) did not move appreciably for films of class A indicating that no significant changes in the electronic band structure occurred. The low energy ($E \lesssim 0.5$ eV) refractive index n on the other hand did show a definite decrease ($n(E \lesssim 0.5 \text{ eV}) \simeq 3.6$) for thin films ($\sim$ 500 Å) relative to thicker films and relative to the crystalline value ($n = 4.0$). This result can be interpreted as due to mere mass density deficit without having to involve any appreciable changes in the optical matrix elements. In the investigated film of class B on the other hand, the low energy refractive index was found to lie above the crystalline value indicating that despite an appreciable density deficit the weight of the optical absorption shifted to lower energies and therefore a change in the underlying electronic band structure relative to films of class A seems to be involved (optical sum rule). On annealing the refractive index tends to decrease to lower values and it is believed that it is this change that is related to the d.c.-electrical conductivity relaxational behaviour generally observed in class B film (discussed above).

It has to be stressed however that before any definite conclusions can be drawn, more quantitative investigations have to be carried out. Such a study using the UHV-system is rather difficult to undertake mainly becouse of the complexity of each single experiment when performed under UHV-conditions and in-situ. It seems however that some of the qualitative trends observed in the present investigation should not or might not depend on the UHV-conditions and in-situ

nature of various experiments making the ex-situ quantitative studies possible and feasible.

VI. CONCLUSIONS

Using a non-destructive, in-situ technique, the density of stable, amorphous germanium films, prepared by slow evaporation onto heated sapphire substrates in ultra high vacuum, was measured. Contrary to the previous results, the density found was lower than that of the crystal. The density deficit dependence on the thermal history of investigated films was explained by a simple relaxation process involving a single activation energy of 1.42 eV. This dependence was found to be unrelated to the d.c.electrical properties in class A films, but could explain some changes in the low energy refractive index in these films.

VII. ACKNOWLEDGEMENTS

The experimental part of this work was carried out in P.C.S.group at the Cavendish Laboratory, University of Cambridge, England. It is a pleasure to acknowledge A.D.Yoffe for his continous interest and support.

The author would like to thank also N.B.Olsen for bringing to his attention both the unpublished data on the d.c.-electrical conductivity annealing behaviour in amorphous germanium films (class B) and the existence of non-exponential relaxation model to explain these.

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FIGURE CAPTIONS

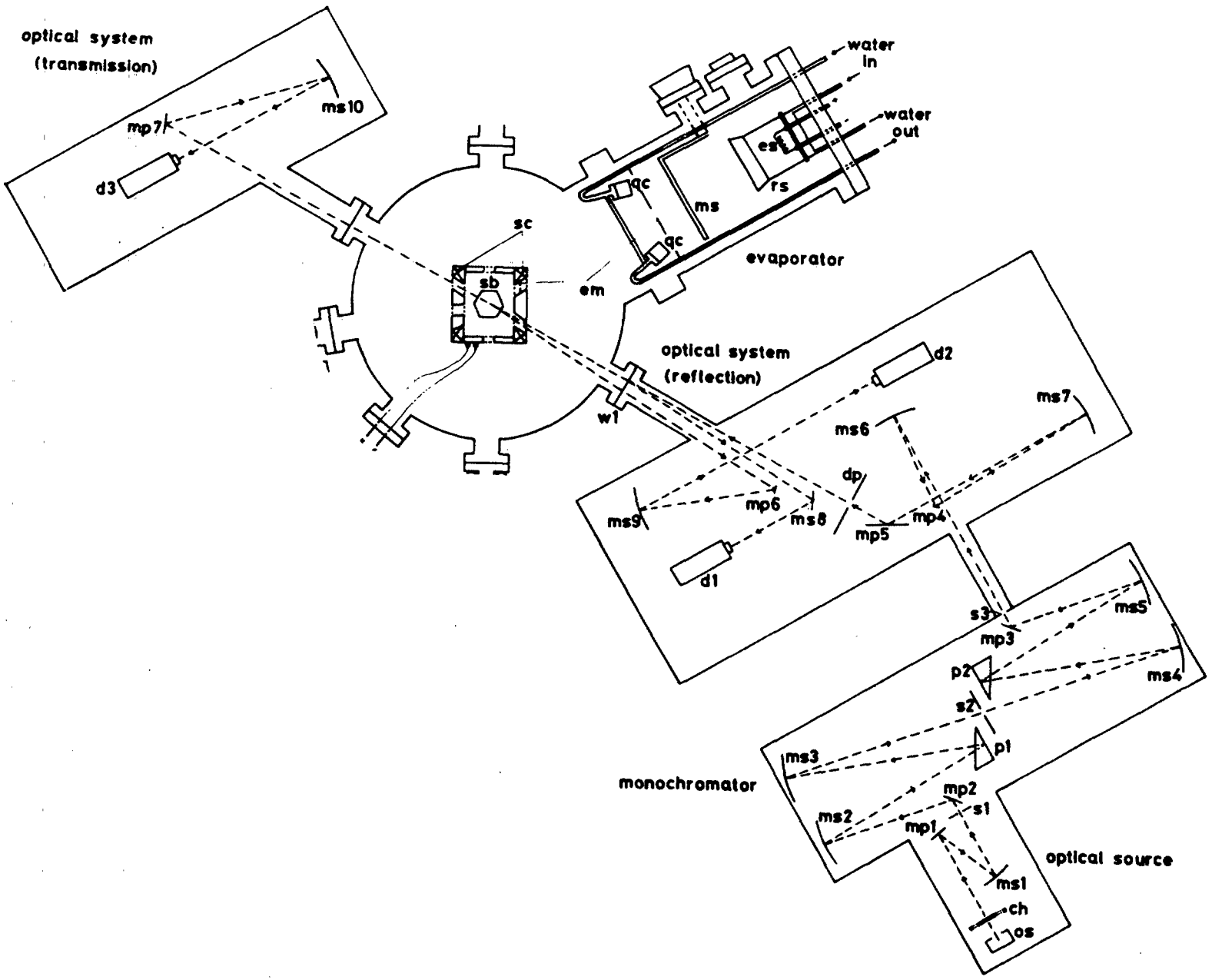
Figure 1 Schematic diagram of the sample block, the evaporator and the optical system. es-evaporation source, rs-radiation shield, ms-mechanical shutter, qc-quartz crystal oscillator, em-evaporation mask, sb-sample block.

Figure 2 Calibration plot of measured density ρ versus measured df/t (frequency change divided by the thickness) for a set of gold films.

Figure 3 The measured density of a-Ge films as a function of their thickness for four films of class A and one film of class B. Also indicated in the figure is the crystalline germanium density.

Figure 4 High resolution bright field electron micrograph of thin a-Ge film of class A investigated in this work (Magnification $\sim 1.6 \cdot 10^6$).

Figure 5 The measured density of a-Ge films as a function of the total evaporation and/or annealing time. Also shown are the predicted density relaxation curves according to the simple model discussed in the text.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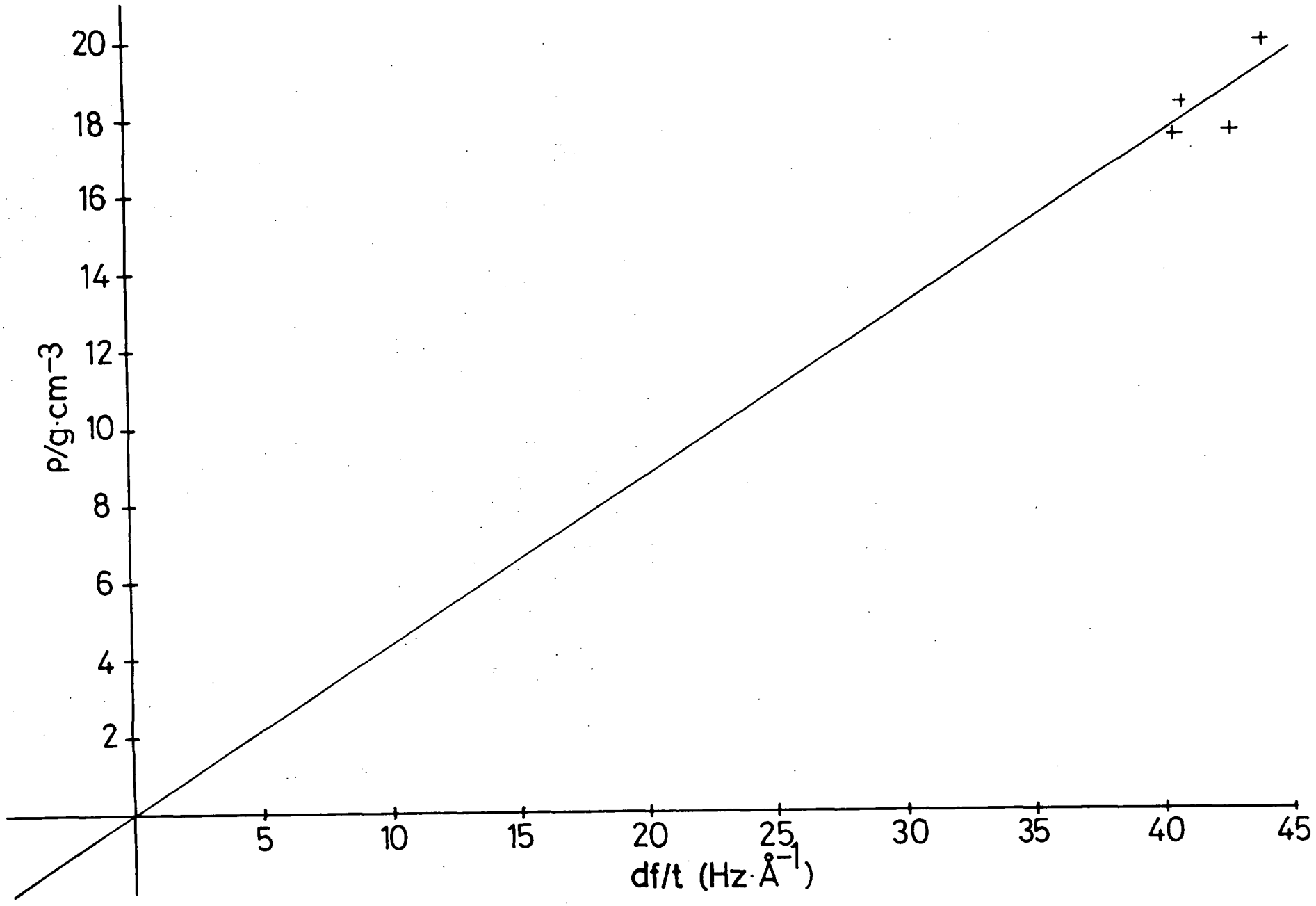
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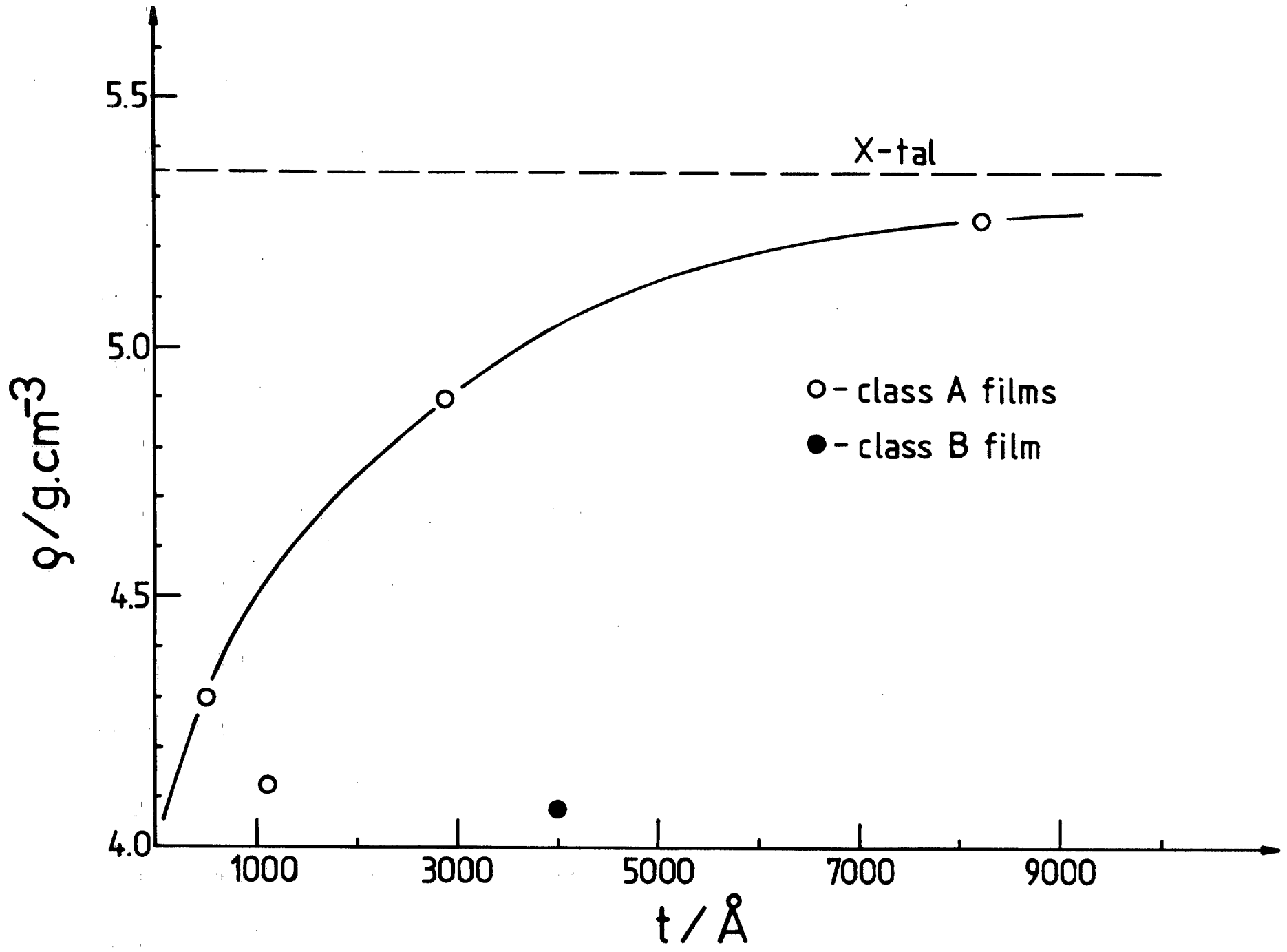
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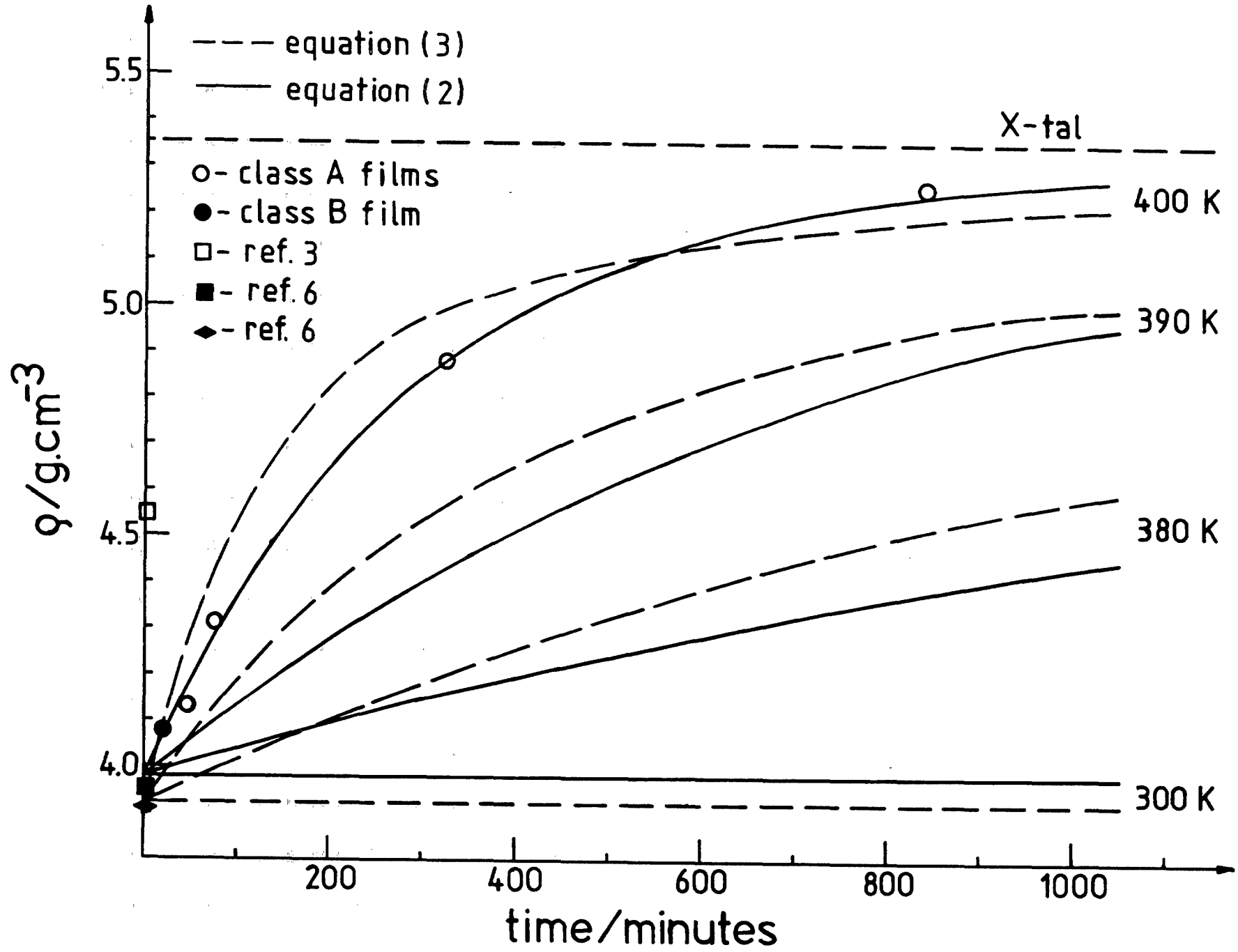
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ρ/g.cm⁻³
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600
800
1000
time/minutes

1/78 "TANKER OM EN PRAKSIS" - et matematikprojekt.
Projektrapport af: Anne Jensen, Lena Lindenskov, Marianne Kesselhahn og Nicolai Lomholt.
Vejleder: Anders Madsen

2/78 "OPTIMERING" - Menneskets forøgede beherskelsesmuligheder af natur og samfund.
Projektrapport af: Tom J. Andersen, Tommy R. Andersen,Gert Krenøe og Peter H. Lassen
Vejleder: Bernhelm Boss.

3/78 "OPGAVESAMLING", breddekursus i fysik.
Af: Lasse Rasmussen, Aage Bonde Kræmmer og Jens Højgaard Jensen.

4/78 "TRE ESSAYS" - om matematikundervisning, matematiklæreruddannelsen og videnskabsrindalismen.
Af: Mogens Niss
Nr. 4 er p.t. udgået.

5/78 "BIBLIOGRAFISK VEJLEDNING til studiet af DEN MODERNE FYSIKS HISTORIE".
Af: Helge Kragh.
Nr. 5 er p.t. udgået.

6/78 "NOGLE ARTIKLER OG DEBATINDLÆG OM - læreruddannelse og undervisning i fysik, og - de naturvidenskabelige fags situation efter studenteroprøret".
Af: Karin Beyer, Jens Højgaard Jensen og Bent C. Jørgensen.

7/78 "MATEMATIKKENS FORHOLD TIL SAMFUNDSØKONOMIEN".
Af: B.V. Gnedenko.
Nr. 7 er udgået.

8/78 "DYNAMIK OG DIAGRAMMER". Introduktion til energy-bond-graph formalismen.
Af: Peder Voetmann Christiansen.

9/78 "OM PRAKSIS' INDFLYDELSE PÅ MATEMATIKKENS UDVIKLING". - Motiver til Kepler's: "Nova Stereometria Doliorum Vinariom".
Projektrapport af: Lasse Rasmussen .
Vejleder: Anders Madsen.

10/79 "TERMODYNAMIK I GYMNASIET".
Projektrapport af: Jan Christensen og Jeanne Mortensen.
Vejledere: Karin Beyer og Peder Voetmann Christiansen.

11/79 "STATISTISKE MATERIALER".
Af: Jørgen Larsen.

12/79 "LINEÆRE DIFFERENTIALLIGNINGER OG DIFFERENTIALLIGNINGSSYSTEMER".
Af: Mogens Brun Heefelt.
Nr. 12 er udgået.

13/79 "CAVENDISH'S FORSØG I GYMNASIET".
Projektrapport af: Gert Kreinøe.
Vejleder: Albert Chr. Paulsen.

14/79 "BOOKS ABOUT MATHEMATICS: History, Philosophy, Education, Models, System Theory, and Works of".
Af: Else Høyrup.
Nr. 14 er p.t. udgået.

15/79 "STRUKTUREL STABILITET OG KATASTROFER i systemer i og udenfor termodynamisk ligevægt".
Specialeopgave af: Leif S. Striegler.
Vejleder: Peder Voetmann Ckristiansen.

16/79 "STATISTIK I KRÆFTFORSKNINGEN".
Projektrapport af: Michael Olsen og Jørn Jensen.
Vejleder: Jørgen Larsen.

17/79 "AT SPØRGE OG AT SVARE i fysikundervisningen".
Af: Albert Christian Paulsen.

18/79 "MATHEMATICS AND THE REAL WORLD", Proceedings af an International Workshop, Roskilde University Centre, Denmark, 1978.
Preprint.
Af: Bernhelm Booss og Mogens Niss (eds.)

19/79 "GEOMETRI, SKOLE OG VIRKELIGHED".
Projektrapport af: Tom J. Andersen,Tommy R. Andersen og Per H.H. Larsen.
Vejleder: Mogens Niss.

20/79 "STATISTISKE MODELLER TIL BESTEMMELSE AF SIKRE DOSER FOR CARCINOGENE STOFFER".
Projektrapport af: Michael Olsen og Jørn Jensen.
Vejleder: Jørgen Larsen

21/79 "KONTROL I GYMNASIET-FORMÅL OG KONSEKVENSER".
Projektrapport af: Crilles Bacher, Per S.Jensen, Preben Jensen og Torben Nysteen.

22/79 "SEMIOTIK OG SYSTEMEGENSKABER (1)".
1-port lineært response og støj i fysikken.
Af: Peder Voetmann Christiansen.

23/79 "ON THE HISTORY AF EARLY WAVE MECHANICS - with special emphasis on the role af realitivity".
Af: Helge Kragh.

24/80 a+b "MATEMATIKOPFATTELSER HOS 2.G'ERE".
1. En analyse. 2. Interviewmateriale.
Projektrapport af: Jan Christensen og Knud Lindhardt Rasmussen.
Vejleder: Mogens Niss.

25/80 "EKSAMENSOPGAVER", Dybdemodulet/fysik 1974-79.

26/80 "OM MATEMATISKE MODELLER".
En projektrapport og to artikler.
Af: Jens Højgaard Jensen m.fl.

27/80 "METHODOLOGY AND PHILOSOPHY AF SCIENCE IN PAUL DIRAC's PHYSICS".
Af: Helge Kragh.

28/80 "DIELEKTRISK RELAXATION - et forslag til en ny model bygget på væskernes viscoelastiske egenskaber".
Projektrapport af: Gert Kreinøe.
Vejleder: Niels Boye Olsen.

29/80 "ODIN - undervisningsmateriale til et kursus i differentialligningsmodeller".
Projektrapport af: Tommy R. Andersen, Per H.H. Larsen og Peter H. Lassen.
Vejleder: Mogens Brun Heefelt.

30/80 "FUSIONSENERGIEN - - - ATOMSAMFUNDETS ENDESTATION".
Af: Oluf Danielsen.
Nr. 30 er udgået.

31/80 "VIDENSKABSTEORETISKE PROBLEMER VED UNDERVISNINGS-SYSTEMER BASERET PÅ MÆNGDELÆRE".
Projektrapport af: Troels Lange og Jørgen Karrebæk.
Vejleder: Stig Andur Pedersen.
Nr. 31 er p.t. udgået.

32/80 "POLYMERE STOFFERS VISCOELASTISKE EGENSKABER - BELYST VED HJÆLP AF MEKANISKE IMPEDANSMÅLINGER MÖSSBAUEREFFEKTMÅLINGER".
Projektrapport af: Crilles Bacher og Preben Jensen.
Vejledere: Niels Boye Olsen og Peder Voetmann Christiansen.

33/80 "KONSTITUERING AF FAG INDEN FOR TEKNISK - NATURVIDENSKABELIGE UDDANNELSER. I-II".
Af: Arne Jakobsen.

34/80 "ENVIRONMENTAL IMPACT AF WIND ENERGY UTILIZATION".
ENERGY SERIES NO. I.
Af: Bent Sørensen
Nr. 34 er udgået.

35/80 "HISTORISKE STUDIER I DEN NYERE ATOMFYSIKS UDVIKLING".
Af: Helge Kragh.

36/80 "HVAD ER MENINGEN MED MATEMATIKUNDERVISNINGEN?".
Fire artikler.
Af: Mogens Niss.

37/80 "RENEWABLE ENERGY AND ENERGY STORAGE".
ENERGY SERIES NO. 2.
Af: Bent Sørensen.

38/81 "TIL EN HISTORIETEORI OM NATURERKENDELSE, TEKNOLOGI OG SAMFUND".
Projektrapport af: Erik Gade, Hans Hedal, Henrik Lau og Finn Physant.
Vejledere: Stig Andur Pedersen, Helge Kragh og Ib Thiersen.
Nr. 38 er p.t. udgået.

39/81 "TIL KRITIKKEN AF VÆKSTØKONOMIEN".
Af: Jens Højgaard Jensen.

40/81 "TELEKOMMUNIKATION I DANMARK - oplæg til en teknologivurdering".
Projektrapport af: Arne Jørgensen, Bruno Petersen og Jan Vedde.
Vejleder: Per Nørgaard.

41/81 "PLANNING AND POLICY CONSIDERATIONS RELATED TO THE INTRODUCTION OF RENEWABLE ENERGY SOURCES INTO ENERGY SUPPLY SYSTEMS".
ENERGY SERIES NO. 3.
Af: Bent Sørensen.

42/81 "VIDENSKAB TEORI SAMFUND - En introduktion til materialistiske videnskabsopfattelser".
Af: Helge Kragh og Stig Andur Pedersen.

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2."ADVANTAGES AND DISADVANTAGES OF DECENTRALIZATION".
ENERGY SERIES NO. 4.
Af: Bent Sørensen.

44/81 "HISTORISKE UNDERSØGELSER AF DE EKSPERIMENTELLE FORUDSÆTNINGER FOR RUTHERFORDS ATOMMODEL".
Projektrapport af: Niels Thor Nielsen.
Vejleder: Bent C. Jørgensen.

45/82 Er aldrig udkommet.

46/82 "EKSEMPLARISK UNDERVISNING OG FYSISK ERKENDESE-
1+11 ILLUSTRERET VED TO EKSEMPLER".
Projektrapport af: Torben O.Olsen, Lasse Rasmussen og Niels Dreyer Sørensen.
Vejleder: Bent C. Jørgensen.

47/82 "BARSEBÄCK OG DET VÆRST OFFICIELT-TÆNKELIGE UHELD".
ENERGY SERIES NO. 5.
Af: Bent Sørensen.

48/82 "EN UNDERSØGELSE AF MATEMATIKUNDERVISNINGEN PÅ ADGANGSKURSUS TIL KØBENHAVNS TEKNIKUM".
Projektrapport af: Lis Eilertzen, Jørgen Karrebæk, Troels Lange, Preben Nørregaard, Lissi Pedesen, Laust Rishøj, Lill Røn og Isac Showiki.
Vejleder: Mogens Niss.

49/82 "ANALYSE AF MULTISPEKTRALE SATELLITBILLEDER".
Projektrapport af: Preben Nørregaard.
Vejledere: Jørgen Larsen og Rasmus Ole Rasmussen.

50/82 "HERSLEV - MULIGHEDER FOR VEDVARENDE ENERGI I EN LANDSBY".
ENERGY SERIES NO. 6.
Rapport af: Bent Christensen, Bent Hove Jensen, Dennis B. Møller, Bjarne Laursen, Bjarne Lillethorup og Jacob Mørch Pedersen.
Vejleder: Bent Sørensen.

51/82 "HVAD KAN DER GØRES FOR AT AFHJÆLPE PIGERS BLOKERING OVERFOR MATEMATIK ?"
Projektrapport af: Lis Eilertzen, Lissi Pedersen, Lill Røn og Susanne Stender.

52/82 "DESUSPENSION OF SPLITTING ELLIPTIC SYMBOLS".
Af: Bernhelm Booss og Krzysztof Wojciechowski.

53/82 "THE CONSTITUTION OF SUBJECTS IN ENGINEERING EDUCATION".
Af: Arne Jacobsen og Stig Andur Pedersen.

54/82 "FUTURES RESEARCH" - A Philosophical Analysis of Its Subject-Matter and Methods.
Af: Stig Andur Pedersen og Johannes Witt-Hansen.

55/82 "MATEMATISKE MODELLER" - Litteratur på Roskilde Universitetsbibliotek.
En biografi.
Af: Else Høyrup.

Vedr. tekst nr. 55/82 se også tekst nr. 62/83.

56/82 "EN - TO - MANGE" -
En undersøgelse af matematisk økologi.
Projektrapport af: Troels Lange.
Vejleder: Anders Madsen.

57/83 "ASPECT EKSPERIMENTET"-
Skjulte variable i kvantemekanikken?
Projektrapport af: Tom Juul Andersen.
Vejleder: Peder Voetmann Christiansen.
Nr. 57 er udgået.

58/83 "MATEMATISKE VANDRINGER" - Modelbetragtninger over spredning af dyr mellem småbiotoper i agerlandet.
Projektrapport af: Per Hammershøj Jensen og Lene Vagn Rasmussen.
Vejleder: Jørgen Larsen.

59/83 "THE METHODOLOGY OF ENERGY PLANNING".
ENERGY SERIES NO. 7.
Af: Bent Sørensen.

60/83 "MATEMATISK MODEKSPERTISE"- et eksempel.
Projektrapport af: Erik O. Gade, Jørgen Karrebæk og Preben Nørregaard.
Vejleder: Anders Madsen.

61/83 "FYSIKS IDEOLOGISKE FUNKTION, SOM ET EKSEMPEL PÅ EN NATURVIDENSKAB - HISTORISK SET".
Projektrapport af: Annette Post Nielsen.
Vejledere: Jens Høyrup, Jens Højgaard Jensen og Jørgen Vogelius.

62/83 "MATEMATISKE MODELLER" - Litteratur på Roskilde Universitetsbibliotek.
En biografi 2. rev. udgave.
Af: Else Høyrup.

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ENERGY SERIES No. 8.
Af: David Crossley og Bent Sørensen.

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Af: Berhelm Booss og Jens Høyrup.

65/83 "ANVENDT MATEMATIK - TEORI ELLER PRAKSIS".
Projektrapport af: Per Hedegård Andersen, Kirsten Habekost, Carsten Holst-Jensen, Annelise von Moos, Else Marie Pedersen og Erling Møller Pedersen.
Vejledere: Bernhelm Booss og Klaus Grünbaum.

66/83 "MATEMATISKE MODELLER FOR PERIODISK SELEKTION I ESCHERICHIA COLI".
Projektrapport af: Hanne Lisbet Andersen, Ole Richard Jensen og Klavs Frisdahl.
Vejledere: Jørgen Larsen og Anders Hede Madsen.

67/83 "ELEPSOIDE METODEN - EN NY METODE TIL LINEÆR PROGRAMMERING?"
Projektrapport af: Lone Biilmann og Lars Boye.
Vejleder: Mogens Brun Heefelt.

68/83 "STOKASTISKE MODELLER I POPULATIONSGENETIK"
- til kritikken af teoriladede modeller.
Projektrapport af: Lise Odgård Gade, Susanne Hansen, Michael Hviid og Frank Mølgård Olsen.
Vejleder: Jørgen Larsen.

69/83 "ELEVFORUDSÆTNINGER I FYSIK"
- en test i 1.g med kommentarer.

Af: Albert C. Paulsen.

70/83 "INDLÆRINGS - OG FORMIDLINGSPROBLEMER I MATEMATIK PÅ VOKSENUNDERVISNINGSNIVEAU".
Projektrapport af: Hanne Lisbet Andersen, Torben J. Andreasen, Svend Åge Houmann, Helle Glerup Jensen, Keld Fl. Nielsen, Lene Vagn Rasmussen.
Vejleder: Klaus Grünbaum og Anders Hede Madsen.

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- et problem og en udfordring for skolen?
Af: Karin Beyer, Sussanne Blegaa, Birthe Olsen, Jette Reich og Mette Vedelsby.

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Af: Peder Voetmann Christiansen.

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- økologisk contra traditionelt.
ENERGY SERIES NO. 9
Specialeopgave i fysik af: Bent Hove Jensen.
Vejleder: Bent Sørensen.

74/84 "MINIATURISERING AF MIKROELEKTRONIK" - om videnskabeliggjort teknologi og nytten af at lære fysik.
Projektrapport af: Bodil Harder og Linda Szkotak Jensen.
Vejledere: Jens Højgaard Jensen og Bent C. Jørgensen.

75/84 "MATEMATIKUNDERVISNINGEN I FREMTIDENS GYMNASIUM"
- Case: Lineær programmering.
Projektrapport af: Morten Blomhøj, Klavs Frisdahl og Frank Mølgaard Olsen.
Vejledere: Mogens Brun Heefelt og Jens Bjørneboe.

76/84 "KERNEKRAFT I DANMARK?" - Et høringssvar indkaldt af miljøministeriet, med kritik af miljøstyrelsens rapporter af 15. marts 1984.
ENERGY SERIES No. 10
Af: Niels Boye Olsen og Bent Sørensen.

77/84 "POLITISKE INDEKS - FUP ELLER FAKTA?"
Opinionsundersøgelser belyst ved statistiske modeller.
Projektrapport af: Svend Åge Houmann, Keld Nielsen og Susanne Stender.
Vejledere: Jørgen Larsen og Jens Bjørneboe.

78/84 "JÆVNSTRØMSLEDNINGSEVNE OG GITTERSTRUKTUT I AMORFT GERMANIUM".
Specialrapport af: Hans Hedal, Frank C. Ludvigsen og Finn C. Physant.
Vejleder: Niels Boye Olsen.

79/84 "MATEMATIK OG ALMENDANNELSE".
Projektrapport af: Henrik Coster, Mikael Wennerberg Johansen, Povl Kattler, Birgitte Lydholm og Morten Overgaard Nielsen.
Vejleder: Bernhelm Booss.

80/84 "KURSUSMATERIALE TIL MATEMATIK B".
Af: Mogens Brun Heefelt.

81/84 "FREKVENSAFHÆNGIG LEDNINGSEVNE I AMORFT GERMANIUM".
Specialerapport af: Jørgen Wind Petersen og Jan Christensen.
Vejleder: Niels Boye Olsen.

82/84 "MATEMATIK - OG FYSIKUNDERVISNINGEN I DET AUTOMATISEREDE SAMFUND".
Rapport fra et seminar afholdt i Hvidovre 25-27 april 1983.
Red.: Jens Højgaard Jensen, Bent C. Jørgensen og Mogens Niss.

83/84 "ON THE QUANTIFICATION OF SECURITY":
PEACE RESEARCH SERIES NO. 1
Af: Bent Sørensen
nr. 83 er p.t. udgået

84/84 "NOGLE ARTIKLER OM MATEMATIK, FYSIK OG ALMENDANNELSE".
Af: Jens Højgaard Jensen, Mogens Niss m. fl.

85/84 "CENTRIFUGALREGULATORER OG MATEMATIK".
Specialerapport af: Per Hedegård Andersen, Carsten Holst-Jensen, Else Marie Pedersen og Erling Møller Pedersen.
Vejleder: Stig Andur Pedersen.

86/84 "SECURITY IMPLICATIONS OF ALTERNATIVE DEFENSE OPTIONS FOR WESTERN EUROPE".
PEACE RESEARCH SERIES NO. 2
Af: Bent Sørensen.

87/84 "A SIMPLE MODEL OF AC HOPPING CONDUCTIVITY IN DISORDERED SOLIDS".
Af: Jeppe C. Dyre.

88/84 "RISE, FALL AND RESURRECTION OF INFINITESIMALS".
Af: Detlef Laugwitz.

89/84 "FJERNVARMEOPTIMERING".
Af: Bjarne Lillethorup og Jacob Mørch Pedersen.

90/84 "ENERGI I 1.G - EN TEORI FOR TILRETTELÆGGELSE".
Af: Albert Chr. Paulsen.

91/85 "KVANTETEORI FOR GYMNASIET".
1. Lærervejledning
Projektrapport af: Biger Lundgren, Henning Sten Hansen og John Johansson.
Vejleder: Torsten Meyer.

92/85 "KVANTETEORI FOR GYMNASIET".
2. Materiale
Projektrapport af: Biger Lundgren, Henning Sten Hansen og John Johansson.
Vejleder: Torsten Meyer.

93/85 "THE SEMIOTICS OF QUANTUM - NON - LOCALITY".
Af: Peder Voetmann Christiansen.

94/85 "TREENIGHEDEN BOURBAKI - generalen, matematikeren og ånden".
Projektrapport af: Morten Blomhøj, Klavs Frisdahl og Frank M. Olsen.
Vejleder: Mogens Niss.

95/85 "AN ALTERNATIV DEFENSE PLAN FOR WESTERN EUROPE".
PEACE RESEARCH SERIES NO. 3
Af: Bent Sørensen

96/85 "ASPEKTER VED KRAFTVARMEFORSYNING".
Af: Bjarne Lilletorup.
Vejleder: Bent Sørensen.

97/85 "ON THE PHYSICS OF A.C. HOPPING CONDUCTIVITY".
Af: Jeppe C. Dyre.

98/85 "VALGMULIGHEDER I INFORMATIONSALDEREN".
Af: Bent Sørensen.

99/85 "Der er langt fra Q til R".
Projektrapport af: Niels Jørgensen og Mikael Klintorp.
Vejleder: Stig Andur Pedersen.

100/85 "TALSYSTEMETS OPBYGNING".
Af: Mogens Niss.

101/85 "EXTENDED MOMENTUM THEORY FOR WINDMILLS IN PERTURBATIVE FORM".
Af: Ganesh Sengupta.

102/85 OPSTILLING OG ANALYSE AF MATEMATISKE MODELLER, BELYST VED MODELLER OVER KØERS FODEROPTAGELSE OG - OMSÆTNING".
Projektrapport af: Lis Eilertzen, Kirsten Habekost, Lill Røn og Susanne Stender.
Vejleder: Klaus Grünbaum.

103/85 "ØDSLE KOLDKRIGERE OG VIDENSKABENS LYSE IDEER".
Projektrapport af: Niels Ole Dam og Kurt Jensen.
Vejleder: Bent Sørensen.

104/85 "ANALOGREGNEMASKINEN OG LORENZLIGNINGER".
Af: Jens Jæger.

105/85 "THE FREQUENCY DEPENDENCE OF THE SPECIFIC HEAT AF THE GLASS REANSITION".
Af: Tage Christensen.

"A SIMPLE MODEL AF AC HOPPING CONDUCTIVITY".
Af: Jeppe C. Dyre.
Contributions to the Third International Conference on the Structure of Non - Crystalline Materials held in Grenoble July 1985.

106/85 "QUANTUM THEORY OF EXTENDED PARTICLES".
Af: Bent Sørensen.

107/85 "EN MYG GØR INGEN EPIDEMI".
- flodblindhed som eksempel på matematisk modellering af et epidemiologisk problem.
Projektrapport af: Per Hedegård Andersen, Lars Boye, CarstenHolst Jensen, Else Marie Pedersen og Erling Møller Pedersen.
Vejleder: Jesper Larsen.

108/85 "APPLICATIONS AND MODELLING IN THE MATEMATICS CURRICULUM" - state and trends -
Af: Mogens Niss.

109/85 "COX I STUDIETIDEN" - Cox's regressionsmodel anvendt på studenteroplysninger fra RUC.
Projektrapport af: Mikael Wennerberg Johansen, Poul Katler og Torben J. Andreasen.
Vejleder: Jørgen Larsen.

110/85 "PLANNING FOR SECURITY".
Af: Bent Sørensen

111/85 JORDEN RUNDT PÅ FLADE KORT".
Projektrapport af: Birgit Andresen, Beatriz Quinones og Jimmy Staal.
Vejleder: Mogens Niss.

112/85 "VIDENSKABELIGGØRELSE AF DANSK TEKNOLOGISK INNOVATION FREM TIL 1950 - BELYST VED EKSEMPLER".
Projektrapport af: Erik Odgaard Gade, Hans Hedal, Frank C. Ludvigsen, Annette Post Nielsen og Finn Physant.
Vejleder: Claus Bryld og Bent C. Jørgensen.

113/85 "DESUSPENSION OF SPLITTING ELLIPTIC SYMBOLS II".
Af: Bernhelm Booss og Krzysztof Wojciechowski.

114/85 "ANVENDELSE AF GRAFISKE METODER TIL ANALYSE AF KONTIGENSTABELLER".
Projektrapport af: Lone Biilmann, Ole R. Jensen og Anne-Lise von Moos.
Vejleder: Jørgen Larsen.

115/85 "MATEMATIKKENS UDVIKLING OP TIL RENÆSSANCEN".
Af: Mogens Niss.

116/85 "A PHENOMENOLOGICAL MODEL FOR THE MEYER-NELDEL RULE".
Af: Jeppe C. Dyre.

117/85 "KRAFT & FJERNVARMEOPTIMERING"
Af: Jacob Mørch Pedersen.
Vejleder: Bent Sørensen

118/85 "TILFÆLDIGHEDEN OG NØDVENDIGHEDEN IFØLGE PEIRCE OG FYSIKKEN".
Af: Peder Voetmann Christiansen

119/86 "DET ER GANSKE VIST - - EUKLIDS FEMTE POSTULAT KUNNE NOK SKABE RØRE I ANDEDAMMEN".
Af: Iben Maj Christiansen
Vejleder: Mogens Niss.

120/86 "ET ANTAL STATISTISKE STANDARDMODELLER".
Af: Jørgen Larsen

121/86 "SIMULATION I KONTINUERT TID".
Af: Peder Voetmann Christiansen.

122/86 "ON THE MECHANISM OF GLASS IONIC CONDUCTIVITY".
Af: Jeppe C. Dyre.

123/86 "GYMNASIEFYSIKKEN OG DEN STORE VERDEN".
Fysiklærerforeningen, IMFUFA, RUC.

124/86 "OPGAVESAMLING I MATEMATIK".
Samtlige opgaver stillet i tiden 1974-jan. 1986.

125/86 "UVBY,β - systemet - en effektiv fotometrisk spektralklassifikation af B-,A- og F-stjerner".
Projektrapport af: Birger Lundgren.

126/86 "OM UDVIKLINGEN AF DEN SPECIELLE RELATIVITETSTEORI".
Projektrapport af: Lise Odgaard & Linda Szkotak Jensen
Vejledere: Karin Beyer & Stig Andur Pedersen.

127/86 "GALOIS' BIDRAG TIL UDVIKLINGEN AF DEN ABSTRAKTE ALGEBRA".
Projektrapport af: Pernille Sand, Heine Larsen & Lars Frandsen.
Vejleder: Mogens Niss.

128/86 "SMÅKRYB" - om ikke-standard analyse.
Projektrapport af: Niels Jørgensen & Mikael Klintorp.
Vejleder: Jeppe Dyre.

129/86 "PHYSICS IN SOCIETY"
Lecture Notes 1983 (1986)
Af: Bent Sørensen

130/86 "Studies in Wind Power"
Af: Bent Sørensen

131/86 "FYSIK OG SAMFUND" - Et integreret fysik/historieprojekt om naturanskuelsens historiske udvikling og dens samfundsmæssige betingethed.
Projektrapport af: Jakob Heckscher, Søren Brønd, Andy Wierød.
Vejledere: Jens Høyrup, Jørgen Vogelius, Jens Højgaard Jensen.

132/86 "FYSIK OG DANNELSE"
Projektrapport af: Søren Brønd, Andy Wierød.
Vejledere: Karin Beyer, Jørgen Vogelius.

133/86 "CHERNOBYL ACCIDENT: ASSESSING THE DATA.
ENERGY SERIES NO. 15.
AF: Bent Sørensen.

134/87 "THE D.C. AND THE A.C. ELECTRICAL TRANSPORT IN AsSeTe SYSTEM"
Authors: M.B.El-Den, N.B.Olsen, Ib Høst Pedersen, Petr Viščor

135/87 "INTUITIONISTISK MATEMATIKS METODER OG ERKENDELSESTEORETISKE FORUDSÆTNINGER"
MASTEMATIKSPECIALE: Claus Larsen
Vejledere: Anton Jensen og Stig Andur Pedersen

136/87 "Mystisk og naturlig filosofi: En skitse af kristendommens første og andet møde med græsk filosofi"
Projektrapport af Frank Colding Ludvigsen
Vejledere: Historie: Ib Thiersen
Fysik: Jens Højgaard Jensen

137/87 "HOPMODELLER FOR ELEKTRISK LEDNING I UORDNEDE FASTE STOFFER" - Resume af licentiatafhandling
Af: Jeppe Dyre
Vejledere: Niels Boye Olsen og Peder Voetmann Christiansen.

138/87 "JOSEPHSON EFFECT AND CIRCLE MAP."

Paper presented at The International Workshop on Teaching Nonlinear Phenomena at Universities and Schools, "Chaos in Education". Balaton, Hungary, 26 April-2 May 1987.

By: Peder Voetmann Christiansen

139/87 "Machbarkeit nichtbeherrschbarer Technik durch Fortschritte in der Erkennbarkeit der Natur"

Af: Bernhelm Booss-Bavnbek
Martin Bohle-Carbonell

140/87 "ON THE TOPOLOGY OF SPACES OF HOLOMORPHIC MAPS"

By: Jens Gravesen

141/87 "RADIOMETERS UDVIKLING AF BLODGASAPPARATUR - ET TEKNOLOGIHISTORISK PROJEKT"

Projektrapport af Finn C. Physant

Vejleder: Ib Thiersen

142/87 "The Calderón Projektor for Operators With Splitting Elliptic Symbols"

by: Bernhelm Booss-Bavnbek og
Krzysztof P. Wojciechowski

143/87 "Kursusmateriale til Matematik på NAT-BAS"

af: Mogens Brun Heefelt

144/87 "Context and Non-Locality - A Peircan Approach

Paper presented at the Symposium on the Foundations of Modern Physics The Copenhagen Interpretation 60 Years after the Como Lecture. Joensuu, Finland, 6 - 8 august 1987.

By: Peder Voetmann Christiansen

145/87 "AIMS AND SCOPE OF APPLICATIONS AND MODELLING IN MATHEMATICS CURRICULA"

Manuscript of a plenary lecture delivered at ICMTA 3, Kassel, FRG 8.-11.9.1987

By: Mogens Niss

146/87 "BESTEMMELSE AF BULKRESISTIVITETEN I SILICIUM"

- en ny frekvensbaseret målemetode.

Fysikspeciale af Jan Vedde

Vejledere: Niels Boye Olsen & Petr Viščor

147/87 "Rapport om BIS på NAT-BAS"

redigeret af: Mogens Brun Heefelt

148/87 "Naturvidenskabsundervisning med Samfundsperspektiv"

af: Albert Chr. Paulsen

149/87 "In-Situ Measurements of the density of amorphous germanium prepared in ultra high vacuum"

by: Petr Viščor

150/87 "Structure and the Existence of the first sharp diffraction peak in amorphous germanium prepared in UHV and measured in-situ"

by: Petr Viščor