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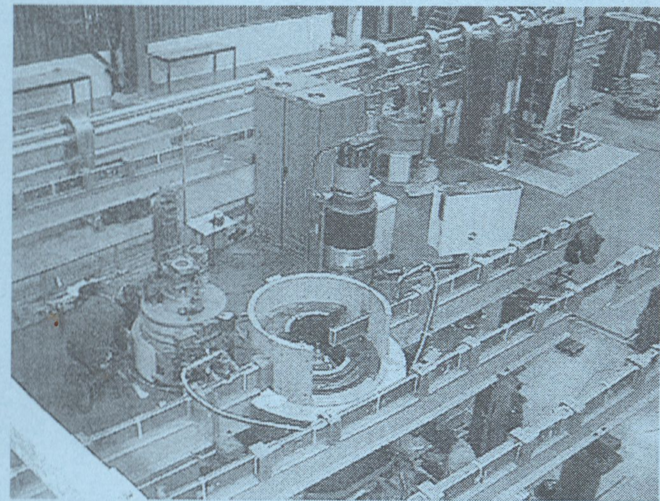
SWISS NEUTRON NEWS



Schweizerische Gesellschaft für Neutronenstreuung
Société Suisse pour la Diffusion des Neutrons
SGN / SSDN

Cover illustration:
The triple axis spectrometer Drüchal very shortly before completion. It is positioned at a supermirror coated neutron guide. Drüchal is taken into operation on Dec. 3 1996 for preliminary tests of the neutron beam.

Impressum:

Herausgeber:	Schweizerische Gesellschaft für Neutronenstreuung	
Vorstand:	Präsident:	Prof. Dr. A. Furrer, ETH Zürich
	Vizepräsident:	Prof. Dr. K. Yvon, Univ. de Genève
	Beisitzer:	Prof. Dr. H.U. Güdel, Univ. Bern
	Sekretär:	Dr. P. Böni, PSI Villigen
Ehrenmitglieder:	Prof. Dr. W. Hälg, ETH Zürich Prof. Dr. K.A. Müller, IBM Rüschlikon und Univ. Zürich	
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Inhaltsverzeichnis

Editorial

Das zu Ende gehende Jahr ist ein Markstein in der langen Geschichte der Neutronenstreuung in der Schweiz. Wenn Sie diese Nummer von *Swiss Neutron News* lesen, wird die **Spallationsquelle SINQ** am Paul Scherrer Institut (PSI) in Villigen die ersten Neutronen produziert haben. Die ganze Nutzergemeinschaft hat der Inbetriebsetzung der SINQ am 3./4. Dezember 1996 mit grossen Erwartungen entgegengefiebert. Die SINQ ist eine hoch komplexe technische Anlage, die von den Projektverantwortlichen und ihren Mitarbeitern mit enormem persönlichem Einsatz und Sachverstand realisiert worden ist. Die Schweizerische Gesellschaft für Neutronenstreuung (SGN) beglückwünscht alle am Projekt SINQ Beteiligten zum erfolgreichen Zustandekommen dieser neuen Grossforschungsanlage, die weit über die Jahrtausendwende hinaus die Forschung am PSI prägen wird. Es liegt an uns Neutronenstreuern, von diesen Möglichkeiten (präsentiert zum fünfjährigen Geburtstag der SGN!) effizient Gebrauch zu machen.

Die Neutronenspezialisten am PSI haben beim Aufbau der Instrumente für Neutronenstreuung alles daran gesetzt, die spezifischen Vorteile der SINQ konsequent zu nutzen und mit teils innovativen Konzepten ein Maximum aus der Maschine herauszuholen. Wenn die SINQ im nächsten Jahr für den Nutzerbetrieb freigegeben wird, soll sie nicht nur für die Forschung eine Quelle neuer Erkenntnisse und Anwendungen bei der Untersuchung der kondensierten Materie sein, sondern auch ein zentrales Element für die Ausbildung darstellen. Forschung und Ausbildung sind klar gekoppelt, denn einerseits führt Forschung ohne Nachwuchs zwangsläufig in eine Sackgasse, andererseits versiegt der Nachwuchs ohne Forschung. Wir wollen an der SINQ die Synthese zwischen Forschung und Ausbildung besonders pflegen. Die Teilnahme mehrerer hundert junger Wissenschaftler an der ECNS'96 (1. Europäische Konferenz über Neutronenstreuung, Oktober 1996, Interlaken, organisiert vom PSI und der SGN in Zusammenarbeit mit der European Neutron Scattering Association ENSA) - der grössten Konferenz, die je auf dem Gebiet der Neutronenstreuung stattgefunden hat - erfüllt uns deshalb mit grosser Zuversicht, dass der akademische Nachwuchs eine aktive Rolle an der SINQ spielen wird.

Albert Furrer
Präsident der SGN

November 1996

4*th* Zuoz School on Neutron Scattering

Ninety participants and lecturers assembled at the Lyceum Alpinum at Zuoz (Switzerland), a small village in the upper Engadine valley, from August 18-24, 1996, for the 4*th* Summer School on Neutron Scattering organized by the Paul Scherrer Institute (PSI) to discuss "New Instruments and Science Around SINQ". The programme consisted of a series of lectures introducing the first-generation instruments installed at the spallation neutron source SINQ at PSI, followed by presentations of typical experiments which can be performed on these instruments. The lecture notes are being combined to the Proceedings to be published by PSI in October 1996. The subjects discussed were:

- Introduction to neutron scattering *(W.E. Fischer)*;
- Single-crystal diffractometer *(J. Schefer)*, quasicrystals *(W. Steurer)*, optical information storage systems *(Th. Woike)*, residual stress *(G.A. Webster)*;
- Powder diffractometers *(P. Fischer)*, supramolecular magnetism *(S. Decurtins)*, metal-insulator transitions *(M. Medarde)*;
- Three-axis spectrometer *(W. Bührer)*, incommensurate phase transitions *(R. Currat)*, martensitic phase transitions *(W. Petry)*;
- Polarized three-axis spectrometer *(P. Böni)*, identification of magnetic modes by polarization analysis *(B. Dorner)*, INVAR *(P.J. Brown)*;
- Time-of-flight spectrometer *(S. Janssen)*, dynamics of polymers *(U. Buchenau)*, magnetic excitations *(B.D. Rainford)*;
- Small-angle diffractometer *(W. Wagner)*, polymers and colloids *(P. Schurtenberger)*;
- Reflectometer *(D. Clemens)*, layered magnets *(H. Zabel)*, polymer surfaces, interfaces and thin films *(M. Stamm)*;
- Non-diffractive methods *(E. Lehmann)*, neutron radiography *(G. Bayon)*, prompt gamma analysis *(J. Kern)*, neutron activation analysis *(H.W. Gäggeler)*;
- Sample environment: dynamic nuclear polarization *(H. Stuhrmann)*, extreme conditions *(J. Mesot)*.

The lectures were presented in the morning, in the late afternoon and sometimes after dinner. Most participants used the free afternoons for sports activities such as mountain climbing, hiking, biking, running, tennis, etc., or just for enjoying the lovely surroundings offered by the picturesque scenery of the Engadine valley.

The tradition will go on! Next year's school will be held from August 10-17, 1997, at the same place, and will focus on "Cold Neutrons: Large Scales - High Resolution", hopefully with first results of experiments performed at SINQ!

Albert Furrer

The almost complete group of invited lecturers.

1*st* European Conference on Neutron Scattering (ECNS'96)

G.H. Lander, Karlsruhe

Almost 700 scientists gathered for the biggest neutron "fest" ever held in Interlaken Switzerland from 8-11 October 1996. The breadth of the program excludes a detailed description in the short space below - the Proceedings of the Conference, which attracted 650 abstracts, will be published in Physica B in 1997.

For the two days before the Conference an introductory school was held with 10 lectures by experts, and this was attended by some 150 "students". The Conference itself opened with a plenary lecture by D. Dubbers (U. of Heidelberg) on "Particle physics with neutrons". Other plenary lectures were given by: R. Wagner (GKSS-Research Center, Geesthacht) on "Neutron Scattering in Materials Science", by J.C. Smith (Saclay) on "Dynamic neutron scattering in biology" and J. Schweizer (CEA-Grenoble) on "Molecular magnetism and neutron scattering". There were as well many excellent invited talks, often in as many as 3 parallel sessions, so that the attendees were required to assimilate some of the precision of timing demonstrated by our excellent hosts.

Special sessions were held on sources and the future, with a Panel discussion and mention of the Report of the Autrans Workshop (see *Neutron News*, Vol. 7.3 p. 5) published by the European Science Foundation. J. Finney (University College, London) and G. Bauer (PSI, Switzerland) discussed the scientific case and accelerator requirements, respectively, of the proposed European Spallation Source (ESS).

As highlight on the Thursday of the Conference was a visit to the "about to operate" PSI neutron source. One could see the massive shielding, the (Swiss) precision instruments, and all that was lacking was a few stray neutrons and a graph or two of a new result. Hopefully, protons will come onto the target in December 1996.

A splendid banquet, prepared by one of the swank hotels in Interlaken, was a memorable occasion on the Thursday evening. The meeting ended on Friday with three summary talks, by J. Colmenero (San Sebastian, Spain), R. Cywinski (U. of St. Andrews) and Ch. de Novion (Saclay) who did a good job of giving some impressions of the new developments at this meeting.

The invited 15 minute talks featured many young scientists, and the Conference ended with awards to 11 young scientists for outstanding work.

Many thanks to the organizers for a superb effort. There are always high expectations for a Conference in Switzerland, but in terms of new ideas and presentation this meeting set new standards. For example, the hosts were able to support almost 100 scientists for the former Eastern block countries, so that the Conference had a most definitive European air, in the broadest sense.

The invited lecturers enjoy the sun in front of the Casino in Interlaken.

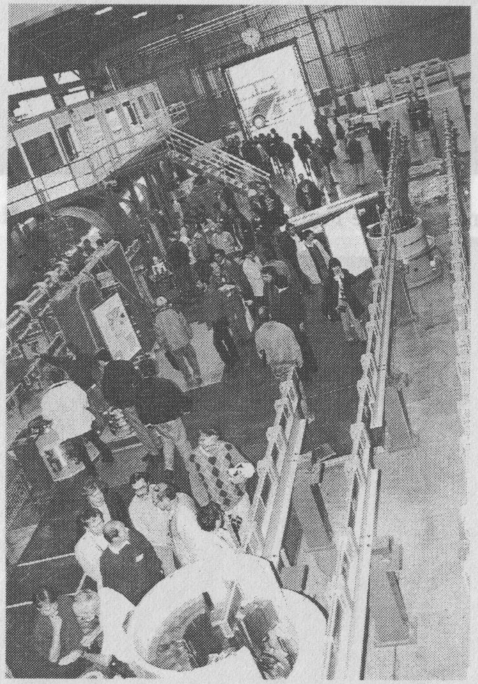
The winners of the eleven young scientist awards and the chairmans of the international programme committee and the organizing committee, Profs. D. Richter and A. Furrer, respectively, assemble in the Congress-Saal. We congratulate in particular the three members of the Swiss Neutron Scattering Society (W. Henggeler, J. Löffler, and M. Medarde), who are under the recipients.

After the work is successfully completed: The organizing committee.

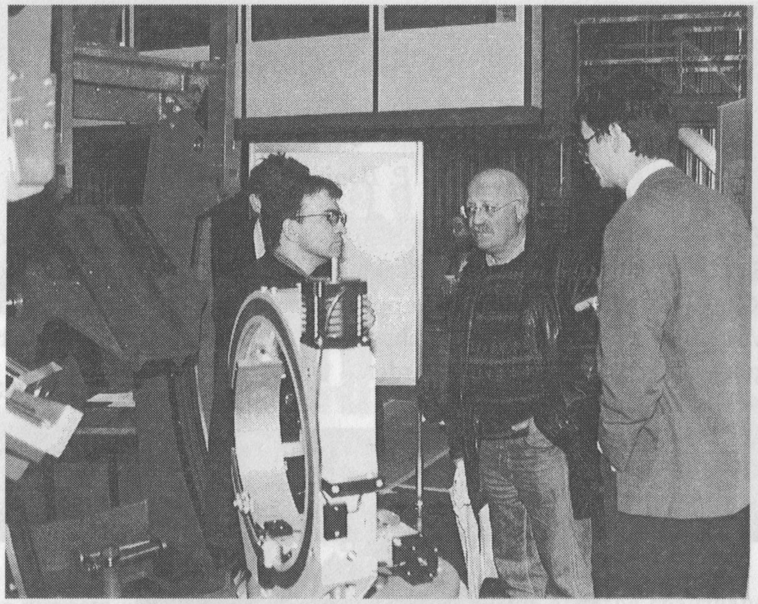
Besuch der SINQ: Ein Rückblick

P. Böni

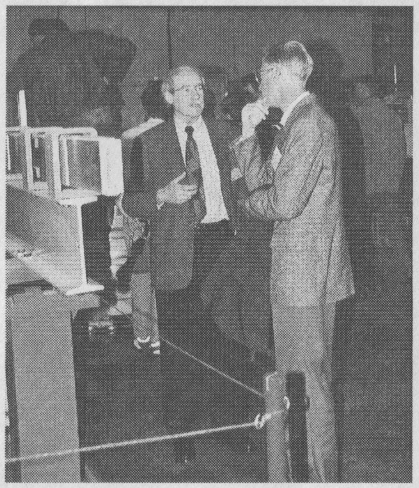
Einer der Höhepunkte der ECNS'96 in Interlaken war der Besuch der Spallationsquelle SINQ am Paul Scherrer Institut. Die Teilnehmer der Konferenz wurden in zwei Gruppen eingeteilt, die gestaffelt zu den Vorträgen an die HTL Windisch, ans PSI und zu einer Stadtbesichtigung nach Luzern gefahren wurden.



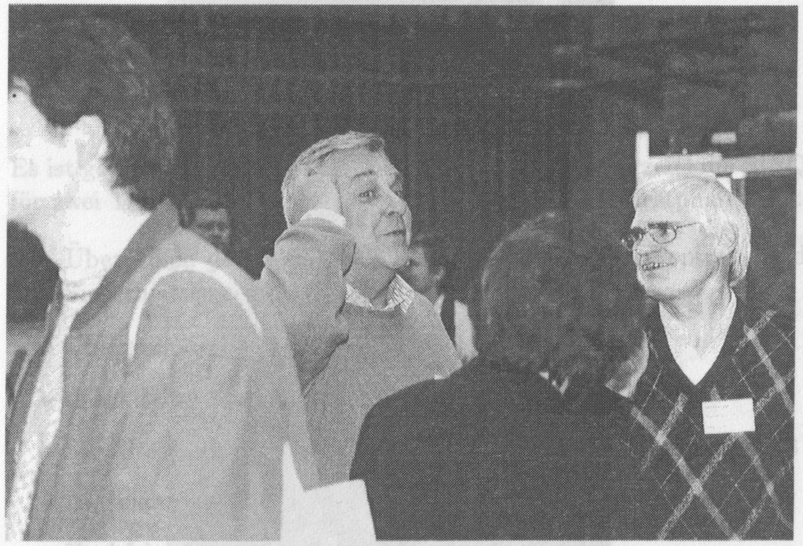
Die Neutronenleiterhalle im Überblick. Im Uhrzeigersinn: Testspektrometer, SANS, polarisiertes Dreiachsenspektrometer, Pulverdiffraktometer und Dreiachsenspektrometer Drüchal.



Jürg Schefer erläutert die Funktionsweise des Vierkreisdiffraktometers TriCS.



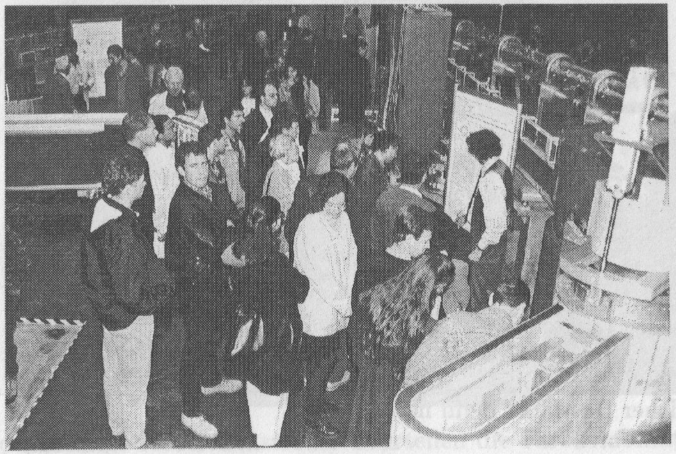
Zwei hochkarätige Neutronenstreuer beurteilen die Farbkombination der Neutronenleiter.



Köpfchen! So funktioniert die SINQ.

Welcher Bus fährt denn nach Luzern?

Die gelben Stahlkolosse dienen der Montage und der Demontage von Einschubteilen.



Andächtige Stimmung beim polarisierten Dreiachsenspektrometer TASP.

Inbetriebnahme der SINQ

Es ist geplant, am 3. Dezember 1996 um 8^{00} (Schweizerzeit) die SINQ für zwei Tage in Betrieb zu nehmen. Die Ziele dieser Testphase sind:

- Überprüfen der Protonenstrahlführung und ihrer Kontroll- und Sicherheitssysteme
- Überprüfung der Abschirmungen
- thermisches Verhalten der Kreisläufe
- Strahltests an den Neutronenspektrometern Drüchal und SANS
- Aktivierungsmessungen mit Goldfolien
- Hochfahren des Protonenstroms von 0 auf 1mA.

Bitte drücken Sie uns allen die Daumen für diese Tests, die uns die Türe öffnen sollen für Neutronenstreuexperimente im Jahr 1997.

5^{th} Zuoz School on Neutron Scattering 1997

The subject of the 5^{th} Summer School on Neutron Scattering will be:

Cold Neutrons: Large Scales - High Resolution

The main purpose of the Summer School is to give participants an introduction into the basic principles and applications of cold neutrons for studies of large scale structures and of slow processes. A separate and more detailed announcement will be distributed early next year.

Neue Mitglieder

P. Böni

Seit dem 1. Juli 1996 ist die Anzahl der SGN-Mitglieder förmlich explodiert! Hier die Namen der neuen Mitglieder:

- M. Rogante, Università di Ancona, Ancona
- A. Rajewska, Institute of Atomic Energy, Swierk-Otwock
- G. Bruno, Università di Ancona, Ancona
- L. Fan, Joint Institute for Nuclear Research, Dubna
- B. Dorner, Institut Laue-Langevin, Grenoble
- M. Böhm, Universität Graz, Graz
- U. Stuhr, Paul Scherrer Institut, Villigen PSI
- J. Kohlbrecher, Paul Scherrer Institut, Villigen PSI
- P. Stadelmann, CIME-EPFL, Lausanne
- G. Böttner, Paul Scherrer Institut, Villigen PSI
- H. Stuhrmann, Forschungszentrum Geesthacht, Geesthacht

Austritte:

- R. Fuchs, Alusuisse Technology and Managment AG, Neuhausen

Generalversammlung 9. Okt. 1996

Theatersaal Congress-Center Interlaken, 12.30 Uhr

TRAKTANDEN

1. **Begrüssung:**
   Der Präsident begrüsst die 39 Anwesenden. Entschuldigt: K. Yvon, G. Kostorz.

2. **Protokoll der GV vom 12.10.1995:**
   Das Protokoll der GV vom 12.10.1995 (Swiss Neutron News Nr. 8) wird genehmigt und verdankt.

3. **Jahresbericht des Präsidenten:**
   Im Jahresbericht orientiert der Präsident über die verschiedenen Aktivitäten der SGN 1995/96:

   - **Veranstaltungen:**
     - 3. PSI-Sommerschule über Neutronenstreuung, 20.-26. August 1995, Lyceum Alpinum, Zuoz, mit 120 Teilnehmern. Thema: "Magnetic Neutron Scattering“.
     - 4. PSI-Sommerschule über Neutronenstreuung, 18.-24. August 1996, Lyceum Alpinum, Zuoz, mit 90 Teilnehmern. Thema: "New Instruments and Science around SINQ“.
   - **Swiss Neutron News:**
     - liefert neueste und aktuellste Informationen
     - Nr. 7 (Juni 1995)
     - Nr. 8 (Dezember 1995)
     - Nr. 9 (Juni 1996)
   - **Kommissionen:**
     siehe Traktandum Nr 7.
   - **Aktuelle Mitgliederzahl:** 157
   - **Ausblick 1997:** siehe Traktandum Nr. 8

4. Jahresrechnung des Kassiers:

Vermögen 1.1.1995 1377.55

	Einnahmen SFr	Ausgaben SFr
Mitgliederbeiträge	1315.–	
Beitrag Sommerschule Zuoz		721.50
Taxen für Postcheck		34.10
Taxen für Eurocheck		5.00
Zins	31.40	
Verrechnungssteuer		11.00
Total	1346.40	771.60
Einnahmen 1995		574.80

Bilanz 31.12.1995

	Aktiven SFr	Passiven SFr
Postcheckkonto	1917.60	
Kasse	34.75	
Vermögen am 1.1.1996		1952.35

5. Bericht der Revisoren:

Die Rechnungsrevisoren haben die Belege, die Abrechnung und die Bilanz für das Jahr 1995 überprüft und für in Ordnung befunden.

Die Jahresrechnung 1995 wird anschliessend von den Anwesenden genehmigt.

6. Budget für das Jahr 1997:

	Einnahmen SFr	Ausgaben SFr
Mitgliederbeiträge	1400.-	
Sommerschule Zuoz		600.–
Diverses		300.–
Taxen für Postcheck		35.–
Zins	35.–	
Verrechnungssteuer		12.–
Total	1435.–	947.–
Einnahmen 1997		488.–

7. Kommissionsberichte:

- ILL (Informationen von G. Kostorz):
  - zuwenig Geld und Personal
  - geschlossene Sitzungen des Scientific Counsels mit dem Direktor sind sehr nützlich
  - Prof. Stirling wurde als Chairman des Scientific Counsil's wiedergewählt
- ENSA (European Neutron Scattering Association):
  - Analyse des Fragebogens der ENSA über Verwendung von Neutronen
  - Workshop in Autrans, Jan. 1996: Neutronenstreuung an heutigen und zukünftigen Neutronenquellen
  - Überblick über heute verfügbare Neutronenquellen
  - Kollaborationen: Monochromatoren, TOF, Detektoren, Software
- OECD Megascience Forum:
  - Review über Programme auf dem Gebiet der Neutronenstreuung
  - Anforderungen an die Forschung in der Neutronenstreuung
  - internationale Kollaborationen
  - Zugang zu Neutronenquellen

8. Aktivitäten im Jahre 1997

- **3. Dez. 1996: Erste Neutronen an der SINQ!**
- 17. Jan. 1996: Einweihung SINQ
- Winter 1997: Info-Tag für Mittelschüler am PSI
- Frühling 1997: Erste User-Experimente an der SINQ
- 5. PSI-Sommerschule über Neutronenstreuung in Zuoz, 10.-16.8.1997, "Neutron Scattering from Large Scale Structures" (?)
- International Conference on Neutron Scattering ICNS'97 in Toronto, 17.-21.8.1997
- Herbst 1997: SINQ User-Meeting, GV97 der SGN im Rahmen dieses Meetings

9. Varia:

- keine Wortmeldungen

Um 13.00 Uhr wird die Behandlung der Traktanden abgeschlossen.

Der Sekretär der SGN, Dr. P. Böni

P. Böni

Konferenzen 1997

Datum	Ort	Thema
16.02.-27.03.	Grenoble	HERCULES (School on Neutron and Synchr. Rad.)
23.02.-01.03.	Planneralm	12th Workshop "Correlated Systems & Superconductivity"
27.02.-28.02.	Neuchâtel	Frühjahrstagung der SPG
28.02.-04.03.	Beijing	M^2S-HTSC-V
03.03.-05.03.	Halle-Wittenberg	9. Deutsche Zeolith-Tagung Martin-Luther-Universität
17.03.-23.03.	Zarechny	XV Int. Workshop on Appl. of Neutron Scattering
22.04.-25.04.	Saint-Malo	12th Int. Conf. on "Solid-Compounds of Transition Elements"
23.05.-04.06.	Erice	25th Crystallographic Course at the Ettore Majorana Centre Direct Methods of Solving Macromolucular Structures
23.05.-04.06.	Erice	26th Crystallographic Course at the Ettore Majorana Centre Electron Crystallography
25.05.-28.05.	Parma	5*th* European Powder Diffraction Conference
23.06.-26.06.	Dubna	Neutron Texture and Stress Analysis
30.06.-03.07.	Eindhoven	EUCAS'97 (3*rd* European Conf. on Appl. Supercond.)
07.07.-11.07.	Wollongong (by Sydney)	THERMEC'97 (Synthesis, Proc. & Appl. HTSC)

Datum	Ort	Thema
13.07.-17.07.	Oxford	5th Int. Conf. "Surface X-Ray and Neutron Scattering"
27.07.-01.08.	Cairns (Austr.)	ICM'97
10.08.-17.08.	Zuoz	5*th* Zuoz Summer School on Neutron Scattering
17.08.-21.08.	Toronto	ICNS'97
24.08.-28.08	Lissabon graphic Meeting ECM 17	17th European Crystallo-
25.08.-28.08.	Leuven	16th General Conf. Condensed Matter Division EPS
27.08.-31.08	Alpe d'Huez	Conf. on Aperiodic Crystals
08.09.-11.09.	Zürich	IV European Conference on Solid State Chemistry ECSSC'97
14.09.-19.09.	Paris	3*rd* Int. Conf. on f-Elements
21.09.-26.09.	Baden-Baden	Int. Conf. Actinides '97
11.10.	Chaux-de-Fonds	Herbsttagung der SPG

Magnetic In-plane Anisotropy in Sputtered FeCo Films and Multilayers

D. Clemens[a], A. Vananti[a], C. Terrier[a], P. Böni[a], B. Schnyder[b], S. Tixier[a], and M. Horisberger[a]

[a]Laboratorium für Neutronenstreuung, ETH Zürich & Paul Scherrer Institut, CH - 5232 Villigen PSI, Switzerland

[b]Paul Scherrer Institut, CH - 5232 Villigen PSI, Switzerland

Abstract

Recent publications report a magnetic in-plane anisotropy in FeCo films and multilayers. This property can be exploited for example to polarize neutrons in a small external field and the remanent magnetization can serve to use the mirrors as a spin selective device. In this work a study on $Fe_{0.50}Co_{0.48}V_{0.02}$ films and multilayers in combination with Ti:N has been performed with regard to the connection between stress in the coating and the in-plane anisotropy using SQUID and MOKE magnetometry as well as mechanical and X-ray stress analysis. The results prove the magnetostrictive nature of the anisotropy resulting from the condensation of sputtered particles arriving at the surface under oblique incidence. The dependence of the remanence on the thickness of the deposited layer is accentuated in this work. For samples as old as two years we have observed a small degree of stress relaxation.

1. Introduction

A magnetic in-plane anisotropy has been found by several authors in FeCo films and multilayers [1-3]. Such coatings are considered for the polarization of neutrons. As a result of the anisotropy a remanent magnetization along the easy axis is found so that FeCoV mirrors can polarize a specularly reflected neutron beam in small external fields. Moreover, due to the pronounced coercitivity of $Fe_{0.50}Co_{0.48}V_{0.02}$, there is still significant neutron polarization if the external field is oriented antiparallel to the magnetization inside the mirror. In order to exploit this behavior and optimize the parameters used during the production of the multilayers, it has been the aim of this work to investigate the origin of the anisotropy dependence on the sputter gas pressure and the thickness of the individual layers.

2. Experimental

Samples have been prepared in a commercially available DC magnetron sputtering system [4]. Circular ($r = 75$ mm) and rectangular (9×500 mm²) $Fe_{0.50}Co_{0.48}V_{0.02}$ and Ti targets have been used, float glass and silicon wafers were used as substrates. The sputter gas was Ar. The desired thickness is realized by regulating the power applied to the target and the speed with which the substrate holder moves through underneath it (Fig.1). Some samples have been produced in a fixed geometry to the target (static sputtering). The partial pressures are controlled by flow meters. The thicknesses have been measured by X-ray reflectometry and profilometry. Stress analysis has been performed using profilometry and an X-ray diffractometer working with Cu-K_α in transmission geometry. A SQUID magnetometer and the magneto-optical Kerr effect (MOKE) supplied the magnetic data.

At first, for single FeCo layers of ~100 nm, we determined the mechanical stress by scanning the surface profile of Si substrates before and after coating. Thus, we could deduce the stress induced by the film. We only

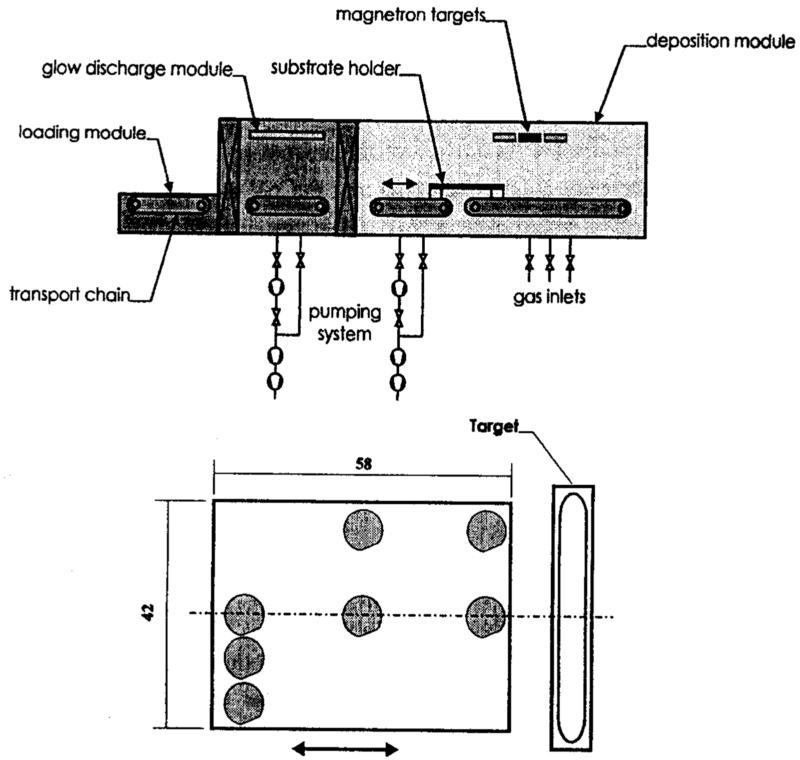


Fig. 1. Scheme drawing of the Leybold Z600 DC-sputtering system and top view of the substrate holder, exemplarily displayed with a representative coverage of 3" silicon wafers that are used for stress analysis.

have to consider intrinsic in-plane stress σ^f, which through Young's modulus E, the Poisson number υ, the radii R_x in x- and R_y in y-direction, and the thicknesses D_s of the substrate and D_f of the film, is given by

$$\sigma_x^f = \frac{E\,D_s^2}{6\,(1-\upsilon^2)\,D_f}\left(\frac{1}{R_x}+\frac{\upsilon}{R_y}\right) \quad (1).$$

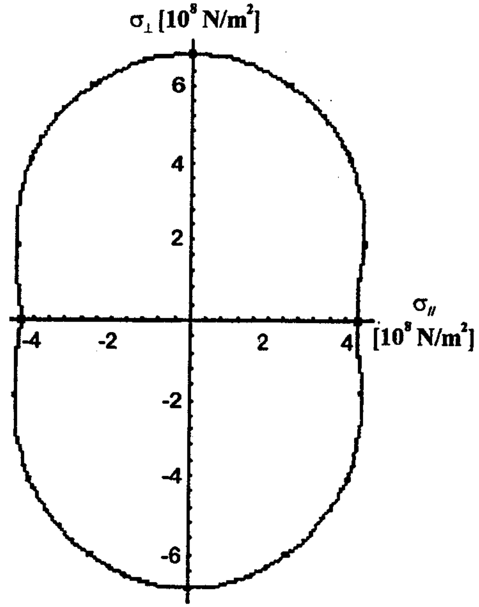


Fig. 2. Polar representation of the stress in a 360 nm FeCo film on silicon as measured by profilometry. // is parallel to the substrate transport direction.

For σ_y one has to exchange indices. In Fig. 2 we exemplarily present the angular stress dependence for a typical sample produced on a moving table. It can be noted that the stress is tensile and has its largest values perpendicular to the transport direction in the sputter chamber.

The stress is the same on a line crossing a given part of the target but is less pronounced for substrates that traverse farther away from the central position. This holds for the rectangular target, as the shape of the magnetron field proves to have an important influence on the stress anisotropy. The circular target does not cover the width of the substrate holder. Consequently, the angles of incidence for the sputtered atoms vary with the distance the substrate is mounted relative to the target center.

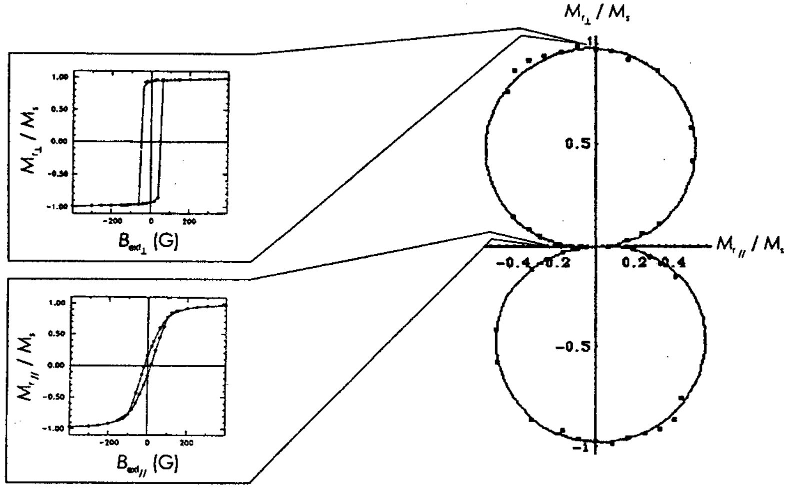


Fig. 3. Remanent magnetization of a a 360 nm FeCo film as measured by MOKE magnetometry (right side) and related hysteresis curves for the easy (top left) and hard axis (bottom left), respectively, obtained from SQUID measurements. // is parallel to the substrate transport direction.

We found an in-plane magnetic anisotropy which has its easy axis along the direction of largest stress (Fig. 3), which is perpendicular to the transport direction. For production in the central position under the rectangular target and $p_{Ar} \leq 0.2$ Pa the hysteresis curves display a remanent magnetization better than 95% of the saturation value M_s, for the easy axis. This behaviour weakens significantly for $p_{Ar} > 0.2$ Pa, resulting in the isotropic magnetization at $p_{Ar} = 0.6$ Pa. Regarding the coercitive field, an analogous development can be noticed. Along the easy axis the coercitive field is $H_c \cong 80$ G at $p_{Ar} \leq 0.2$ Pa, collapsing to $H_c \cong 40$ G at $p_{Ar} > 0.2$ Pa. For off-central positions the samples remain in the anisotropic state for the examined pressure regime $0.06 \leq p_{Ar} \leq 0.6$ Pa. This and the properties for samples produced with static sputtering under oblique incidence indicate that

the asymmetric acceptance angle for sputtered particles in these two cases gives rise to the pronounced anisotropies. This can be explained with a shadowing of longish substrate areas by the deposited material and has been found in [3], as well.

We note that the total stress has the same order of magnitude for FeCoV-Ti:N multilayers having $10\,\text{nm} \leq d_{FeCoV} \leq 100\,\text{nm}$ and $0.1 \cdot d_{FeCoV} \leq d_{Ti:N} \leq 0.3 \cdot d_{FeCoV}$. In a single FeCoV-Ti:N bilayer, σ^f is reduced, whereas σ^f increases with the number of bilayers [5]. For the magnetic anisotropy this results in an increase of H_c with an increasing period number. In SQUID magnetometry performed on a series of FeCoV-Ti:N bilayers we measured a dependence on the speed of the substrate table during deposition, giving rise to a rotation of the easy axis for magnetization (Fig.4).

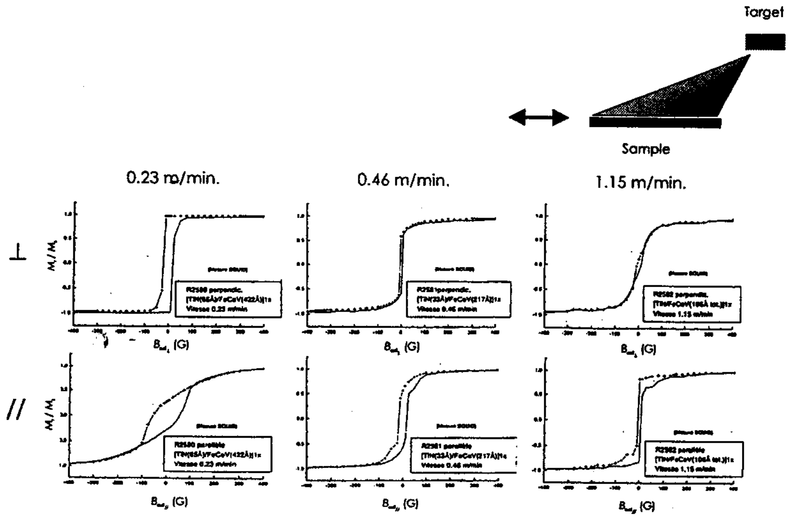


Fig. 4. SQUID hysteresis curves for different substrate table speeds parallel (//) and perpendicular to the movement direction. All samples were produced at $p_{Ar} = 0.1$ Pa.

The magnetic anisotropy has already been exploited for the remanent polarizing neutron mirrors discussed in [1] and [6]. It is for neutron contrast matching that N is introduced into Ti by reactive sputtering. Fig. 5 exemplarily shows the neutron specular reflectivity spectra for the two spin eigenstates obtained from a FeCoV-Ti:N supermirror, i.e., a multilayer with gradually increased single layer thicknesses [7], which is first magnetized to saturation and then placed in an inverse external field $H = -40$ G. The resulting polarization stays on a level, that is still useful in polarized neutron instrumentation.

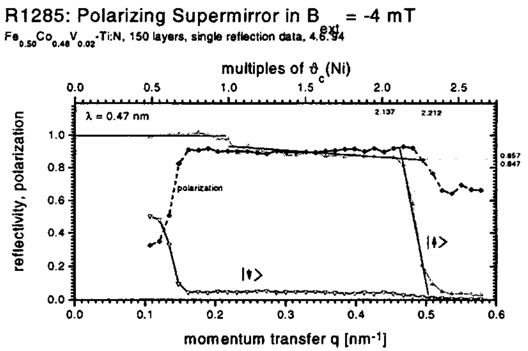


Fig. 5. Polarized neutron reflectivity from a supermirror in an external field that is inversely oriented to its magnetization, previously saturated in ~30 mT along the easy axis.

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