

Technical Report

Results of Questionnaire Survey on Depth Profiling Performed in Surface Analysis Society of Japan

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Responses to questionnaires for depth profiling (DP) were summarized. The questionnaires were performed to collect general issues in DP and needs from practical analysis. It has been revealed that destructive sputter DP performed with a help of surface analytical techniques is still a frequently used and powerful technique in practical analysis in industries. The high spatial- and depth-resolutions and high sensitivity are strongly required as a further development in analytical techniques for DP. Meanwhile, a wider analysis area and deeper depth region are also highly needed depending on samples in industries. In addition to the development of techniques from a view point of hardware, data analysis and understanding of depth profiles with high accuracy and traceability are also very important issues in practical applications. International standards dealing with DP are possible solutions for the improvement in the quality of DP of materials and devices required in practical analysis in industries.

1. Introduction

Depth profiling (DP) usually means obtaining compositional in-depth profiles and has been one of the most important and frequently used analytical techniques applied to practical analysis of materials and devices in industries. DP is related to many analytical techniques [1], e.g., surface electron spectroscopy such as x-ray photoelectron spectroscopy (XPS) and Auger electron spectroscopy (AES), secondary ion mass spectrometry (SIMS) and Rutherford backscattering spectroscopy (RBS), in which ions are used as a signal, cross sectional analysis using scanning electron microscope (SEM) and transmission electron microscope (TEM), and optical analysis such as ellipsometry. Even when the application of XPS to DP is considered, there are several techniques, for instance, angle-resolved XPS (AR-XPS), XPS sputter depth profiling, and hard x-ray XPS (HAXPES) [2] with different elemental peaks. Samples, to which DP is applied, covers a wide range of materials, e.g., both of inorganic and organic materials. The depth range to be

covered by DP is very wide from nm to a couple of μm . Therefore, it is strongly required to appropriately select an analytical technique, pretreatment procedures of samples, measurement conditions, and data analysis procedures according to the purpose of analysis and samples status.

Moreover, in order to choose the most appropriate technique for each analytical request, a sufficient amount of experiences and knowledge on both analytical techniques and materials are essential. In particular, recent developments and automation realized in analytical instruments has changed the equipments further into a black box [3]. This fact makes experiences and knowledge of analysts more important when analysis with highly quantitative and reliable results is needed. This situation is not limited to DP, and it is general tendency in analysis of materials and devices. In addition to a recent development in sophisticated analytical instruments, the range of samples to be analyzed has become wider and also the samples has been categorized

into details. Moreover, strict confidentiality rules are widely applied to information with respect to analytical samples. Therefore, it is getting more difficult for analysts to discuss and share information through academic societies to obtain solution for problems come up against in practical analysis.

With such a background, we performed the questionnaires focused on DP to collect needs from practical analysis among members of Surface Analysis Society of Japan (SASJ). In the present paper, we report the summary of responses to the questionnaires. Another aim of summarizing responses to the questionnaires is to reflect such needs to the development of standards in ISO (International Organization for Standardization)/TC (technical committee) 201/SC (subcommittee) 4 [4] dealing with DP. Note that the questionnaires were originally performed during 4th International Symposium on Practical Surface Analysis (PSA'07) held in 2007 (November 25-28, 2007, Kanazawa, Japan) and the report of the questionnaires survey in Japanese has already been published [5]. Basing on the responses to the questionnaires, International Workshop for Surface Analysis and Standardization '09 (iSAS-09) was organized to provide an opportunity of deep discussion on DP, in particular, for young scientists and engineers in 2009 [6]. A working group (WG) dealing with DP was also established in SASJ [7]. The extended abstracts of iSAS-09 [8] and report of the workshop [9] are freely available on the web site of Journal of Surface Analysis (JSA) [10].

2. Responses to Questionnaires

Since the number of the collected answer sheets was 39, of which more than a half were filled by scientists or engineer from industries, the results was shown as percent when a question was given in the form of options. As a reference, the questionnaires, which were originally written in Japanese, are translated into English for this report and listed in Appendix. Note that, since this questionnaire was performed at PSA'07 conference to reflect responses to SASJ activities, several questions are related to SASJ activities.

Q1: How frequently do you perform DP?

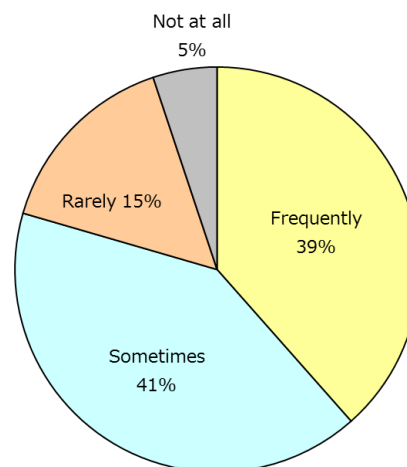


Fig. 1. Frequency in use of DP.

Q2-1: If you selected options of “frequently”, “sometimes”, or “rarely” in Q1, select analytical techniques, which you use in daily analysis, listed below (multiple answers are acceptable).

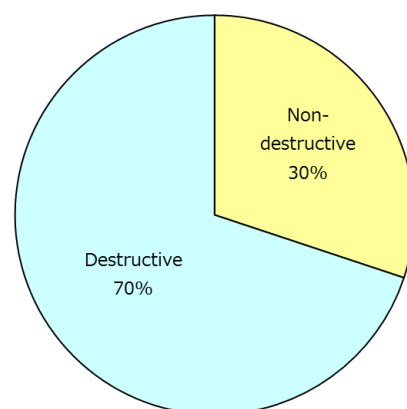


Fig. 2. Frequency in use of non-destructive and destructive DP.

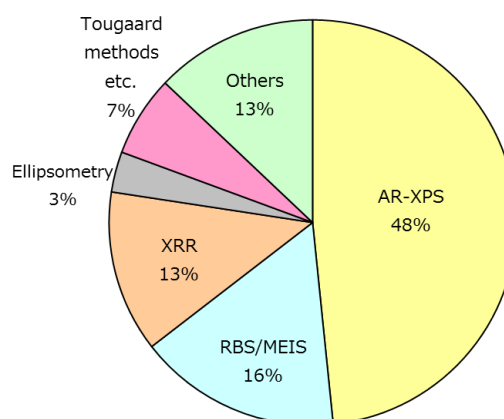


Fig. 3. Categories of non-destructive DP used in daily analysis. Others include attenuated total reflection infrared (ATR-IR), microscopic Raman spectrometer, and simulation of electron spectra for surface analysis (SESSA) [11], and synchrotron radiation -XPS (SR-XPS). Refer [12] for Tougaard method.

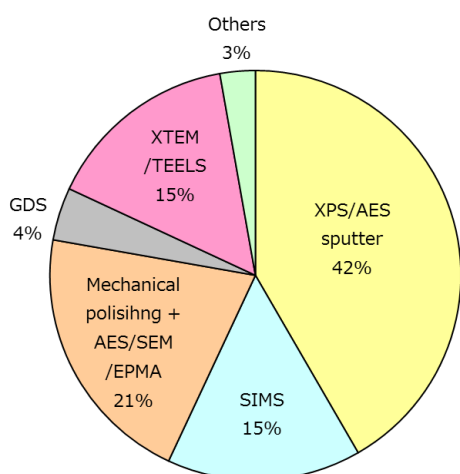


Fig.4. Categories of destructive DP. Others include laser ablation inductively coupled plasma-mass spectrometry (LA-ICPMS).

Q2-2: If you chose options of “frequently”, “sometimes”, or “rarely” in Q1, mark options relevant to depth range that you treat in daily analysis (multiple answers are acceptable).

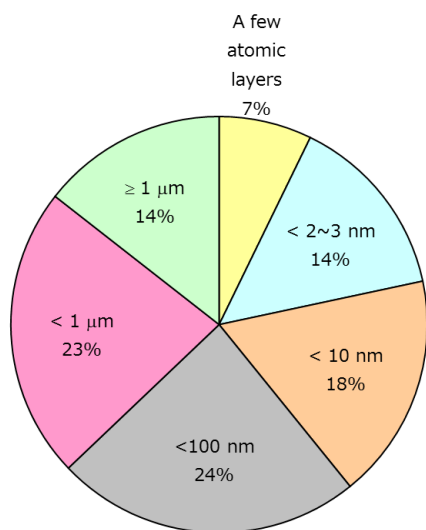


Fig.5. Range of depth dealt with DP.

Q2-3: If you marked options of “frequently”, “sometimes”, or “rarely” in Q1, how much the spatial resolution do you need in daily analysis (multiple answers are acceptable)?

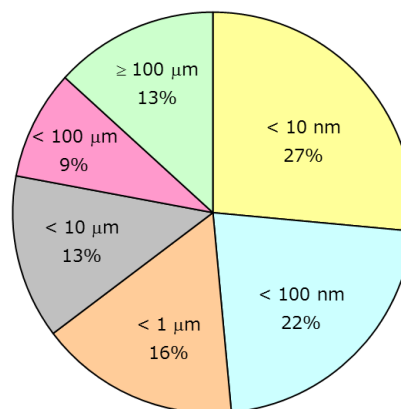


Fig. 6. Spatial resolution required in DP.

Q3-1: If you selected options of “rarely” or “not at all” in Q1, what is the present status of requests to perform DP ?

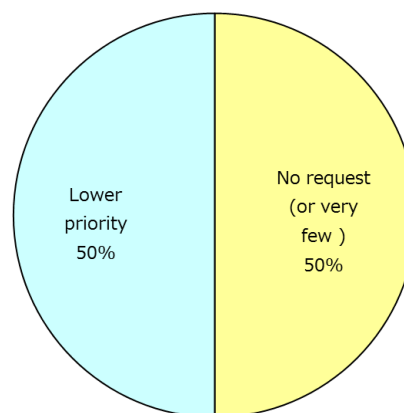


Fig. 7. Present status of requests to perform DP.

Q3-2: If you chose options of “rarely” or “not at all” in Q1, what is the reason for that (multiple answers are acceptable)?

Hardware related issues

- An equipment to sputter polymer and organic materials without damage is not available. ^{†1}
- No budget for a new equipment for sample pretreatment

Issues related to analytical techniques or data analysis

- A true depth scale is not clear for XPS/AES sputter DP.

No request for DP

- Request to perform DP is very rare.

^{†1} At the time when the questionnaires were performed, only a C₆₀ ion source was commercially available.

Q4-1: If you have been using DP or are going to use DP in the near future, do you face or expect any troubles in practical daily analysis?

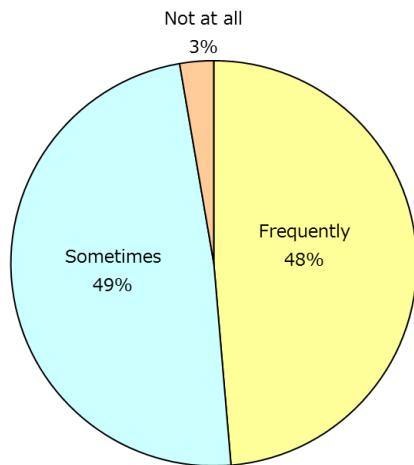


Fig. 8. Frequency of troubles faced in DP.

Q4-2: If you mark options of “frequently” or “sometimes” in Q4-1, what kind of troubles and concerns do you have (multiple answers are acceptable)?

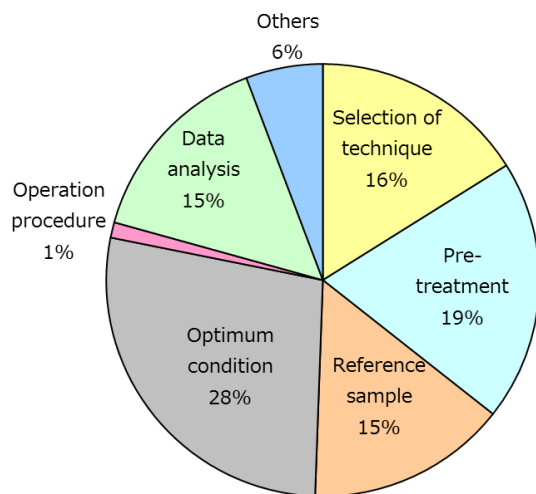


Fig. 9. Troubles and concerns in DP.

Others

- For TEM/EPMA (electron probe microanalyzer): troubles in pretreatment. For XPS/AES: troubles in the selection and preparation of reference samples and data analysis.
- Practical samples are significantly different from ideal samples used in scientific papers and textbooks.
- Sample damage.
- Multilayered samples containing insulating layers.
- Conversion of the sputter time to the depth scale.

Q4-3: If you described any troubles in Q4-2, how do you overcome such problems (multiple answers are

acceptable)?

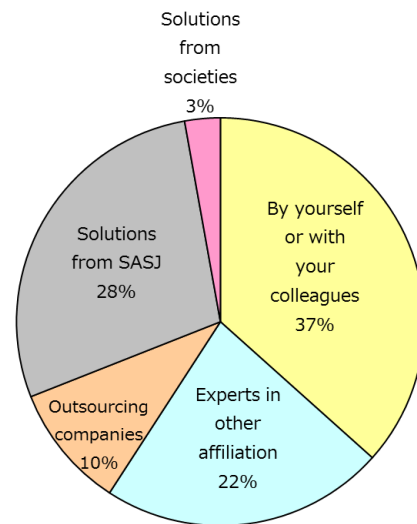


Fig. 10. How to overcome troubles in DP.

Q5-1: If you selected “Expect that you get solutions from SASJ” in Q4-3, how much do you think current SASJ gives you solutions to overcome problems?

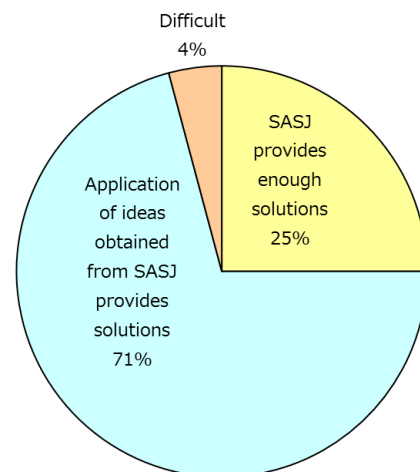


Fig. 11. Present status of SASJ for helping to overcome troubles in depth profiling.

Q5-2: If you marked options of “SASJ provides solutions enough at present” or “SASJ do not provide solution enough but can overcome problems by applying ideas” in Q5-1, what activities do you expect for SASJ (multiple answers are acceptable)?

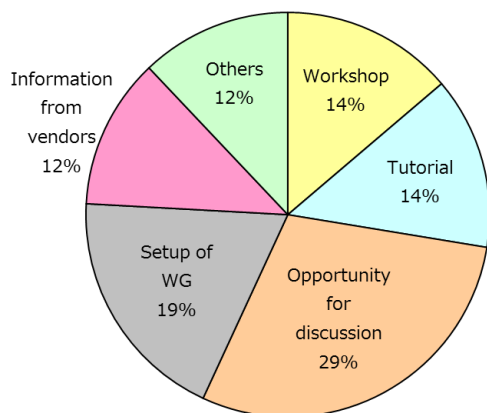


Fig. 12. Expectation for SASJ to overcome problems faced in practical DP analysis.

Others

- Setting up working groups (WGs) dealing with DP including not only XPS/AES but also SIMS.
- Setting up a framework, in which we can ask questions whenever we want and SASJ members give solutions for it.
- I think there are problems in D-SIMS (dynamic SIMS) analysis. Practical samples, e.g., corrosions, do not have a clean surface and D-SIMS analysis of such a surface usually has a large ambiguity. However, analysts do not seem to sufficiently understand such ambiguity and they treat data for practical samples as that for a well-defined surface. Such analysts probably think that D-SIMS works well for many types of samples as this technique works well for well-fabricated semiconductor samples. For instance, significant changes in sensitivity due to matrix effects are not taken into account in many cases.
- I prefer activities in an order of holding workshop, providing opportunities for discussion, and setting up a WG.
- I want to learn the application of cluster ion beams.
- Preparing a web site, where SASJ members can upload questions and answers.
- I think that providing opportunities to have discussion is the most important. It seems that such opportunities have been well provided by SASJ.

Q5-3: If you select an option of "Difficult to solve problems at present" in Q5-1, describe the reason why you think so.

- Our main samples are organic materials and a C₆₀ ion source^{†2} is believed to be one of the possible solutions

for DP of our materials. However, it is not still clear how much this technique and the specification of an equipment are effective. Investigation of the effectiveness of the C₆₀ ion source to practical application by only one organization does not seem to be effective for inspecting its applicability.

^{†2}At the time when the questionnaire was performed, only a C₆₀ ion source was commercially available.

Q6: What do you expect for the development in analytical techniques for DP?

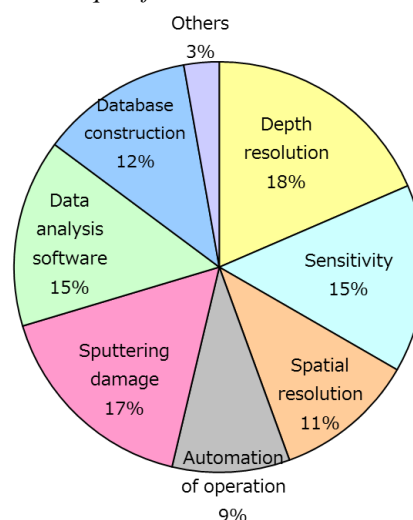


Fig. 13. Expectation for DP.

Others

- Hardware for easier neutralization.
- Improvement in repeatability in sputter depth profiling.
- Improvement in throughput of measurements.

Q7: What do you expect for SASJ activities from a view point of DP?

- I want SASJ to reflect opinions from analysts performing practical analysis to its activities.
- We usually measure main components in samples by XPS/AES and impurities by SIMS so that SIMS is the main technique as DP for us. Therefore, I want SASJ to include SIMS as a topic of a WG activity dealing with DP.
- I prefer a system, in which we can ask questions whenever we want and SASJ members answer to it.
- Providing reference samples to measure sputter rate of various materials
- We are pleased if SASJ can provide information to perform precise DP.

- I need procedures to accurately measure the thickness of oxide films with a large surface/interface roughness.
- We perform DP by using an equipment operated under highly specified conditions. We appreciate if we can get information useful for a further improvement in the accuracy of measurements. I do not think that higher spatial resolution is always necessary, and, in our case, we need a high depth resolution of 1 nm for depth profiles averaged over a wide analysis area of the order of 500 μm . The low sputtering damage as low as possible is also important. A three dimensional mapping with high throughput is also a potential application of DP. Such challenging conditions are strongly required for practical analysis.
- It is better to focus topics for the effective organization of SASJ's activities.
- I am looking for hints to develop a non-destructive DP method applicable for our materials and devices.
- I want Web sites, where I can ask questions faced during analysis and/or try to get information I need.
- Sharing problems faced during measurements and know-hows.
- Introduction of pretreatment procedures in detail. I prefer the situation that manufactures of not only surface analysis instruments but also apparatuses used for such pretreatments join SASJ activities.
- Construction of database of measurement conditions and parameters used in data analysis.
- Organization of international conferences, where young scientists and engineers can join discussion.
- Organization of international symposium focusing on DP, e.g., comparison between techniques from conventional to special techniques such as SR-XPS.
- It is very difficult to report and share our results obtained for our companies' materials. It is favorable to deal with problems faced in DP in practical analysis by performing measurements of standard materials and comparing results among several affiliations.

Q8: What do you expect for SASJ from a view point except for DP?

- I want to discuss about charging in more detail. The chemical analysis by XPS is still difficult because of charging problem.
- Construction of knowledge database on surface analytical techniques.

- I hope the number of young members would increase more.
- Seminar for practical surface analysis.
- In practical analysis, we need knowledge, which is not described in textbooks and scientific papers. I want opportunities to share such knowledge. The publication of textbooks describing such knowledge is also favorable.
- I want SASJ to develop surface cleaning procedures without the sample damage. I also need techniques to measure bulk properties with less surface sensitivity.
- I am satisfied with SASJ activities at present since I have learned so much.

Q9: What kind of topics do you want as a tutorial lecture? We would appreciate if you give your answer from a view point of the improvement in analytical techniques and/or the growth of young engineers working in the field of practical surface analysis. The topics are not limited to DP and those related to other analysis are welcome.

- Introduction of principles of techniques and apparatuses.
- Solving problems related to measurement methods through demonstrations using apparatuses. It is favorable that engineers of the apparatus join it.
- Introduction of basics of measurements such as electronics of a measurement system, signal fluctuation, background formation in a measurement system, principle of signal to noise ratio, etc.
- Lectures covering a wide range of surface analysis and know-how of them.
- Lectures/discussion about data analysis and sample pretreatment for TOF-SIMS (time-of-flight SIMS).
- Lectures for not only the simple operation of apparatuses but also procedures effectively applicable to practical analysis.
- The level of the specification of analytical machines has got much higher than that I was directly involved in the operation of apparatuses. Now it is relatively easy to obtain data by following a manual of an apparatus. However, I believe that experiences are so important and want to give young engineers opportunities to have such experiences. This is so important to check whether or not their own data is correct by themselves. For this, knowledge on materials is essential. So, I think that

important relation is; (quality of data) = (measurement skills)⊗(knowledge about materials)⊗(quality of apparatuses).

- Lectures about curve fitting for XPS including analysis of stoichiometry.
- Providing a routine lecture course for new engineers having no experience of surface analysis.
- Lectures about attention to be paid when we evaluate data obtained by surface analysis, e.g., reliability of quantitative results, how to deal with quantitative values.
- Providing opportunities during a meeting to discuss about questions collected before the meeting in advance.
- I want a lecture teaching us about know-hows of the sample treatment and its effects on data.
- Systematic introduction of practical know-hows with its references. This may be helpful for growing young engineers. Introduction of examples of practical analysis is also very welcome.
- Lectures about typical problems faced during practical analysis and typical solutions to overcome it.

Q10: What is category of your business?

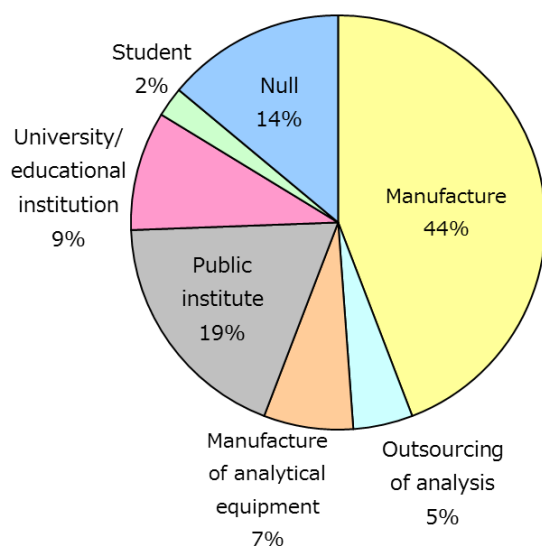


Fig. 14. Categories of business of respondents.

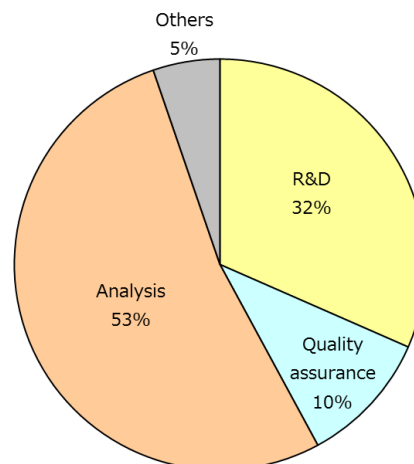


Fig. 15. Division of respondents in manufacturers.

Fields of respondents' company's production

- Metals except for iron
- Ceramics
- Chemicals
- Electronics and chemicals
- Chemicals, bio, and electronic
- Petrochemical
- Outsourcing of fabrication, analysis, and research

3. Questionnaires survey

As easily understood from the answer to Q10 (see Figs. 14 and 15), most of respondents were involved in practical analysis. This is due to the fact that this questionnaire was performed at PSA'07, the topics of which have focused on practical surface analysis. Another reason is that most of members of SASJ, which was the organizing society of PSA'07, belong to companies and deal with practical analysis. The category of business covers a wide range of business, resulting in descriptive responses given from a wide view point. The questionnaires survey for each question is described below.

3.1. Q1~3 (present status of usage of analytical techniques for DP)

We wanted to make it clear how frequently DP was used in practical analysis by Q1~3. It is found that most of respondents deal with DP in their daily works (Q1, Fig. 1). The destructive DP is still fluently-used and one third of analysis requests of DP were performed in a non-destructive manner (Q2-1, Fig. 2). Among

non-destructive DP, AR-XPS covers a half of them (Q2-1, Fig. 3), indicating that an in-depth compositional distribution near the surface region is important in industries. In addition, it is interesting that not only surface electron spectroscopies and D-SIMS, which are main topics in SASJ, but also ion scattering techniques and optical methods including X-ray are frequently employed for DP. From Fig. 4 (Q2-1), it is clear that more than a half of analyses of destructive DP are carried out by sputter DP including D-SIMS. In addition, cross sectional TEM analysis and combination with inclined polishing have also been powerful technique. These answers indicate that knowledge and experiences of not only electron spectroscopies but also other analytical techniques are essential for the effective analysis of practical materials and devices.

As expected from the responses for Q2-1 dealing with analytical techniques (Figs. 2-4), both the depth range (Q2-2, Fig. 5) and spatial resolution (Q2-2, Fig. 6) to be required cover a wide range. It is interesting that whole range of depth and spatial resolution is equally required, and only a high-depth and/or high-spatial resolutions are not particularly required. Several responses describe that whole ranges of depth and spatial resolution are required, and others require only shallow or deep regions. In some cases, both shallow and deep regions (probably a fine structure in a deep region) are needed depending on samples to be analyzed. These responses indicate that although a high depth and spatial resolutions are academically one of the most important issues, many problems related to other issues potentially exist even from viewpoints of depth and spatial resolutions.

Most of problems faced when DP is hardly/not carried out (Q3-2) seem to be related to “damage” and “calibration of depth scale”, both of which are important issues in later questions as well. The questions, Q1~3, made it clear that these issues are important not only for affiliations carrying out DP but also for those not performing DP (though they want to do DP).

3.2. Q4~5 (problems, possible solutions, and role expected for SASJ)

In order to collect information about problems faced in the daily analysis and provide opportunities to discuss about it among SASJ members, these questions were asked. It is found that various kinds of samples are

to be analyzed in the daily analysis, resulting in many kinds of troubles (Q4-1, Fig. 8). When troubles are categorized into steps from “before analysis” (selection of technique) to “after measurements” (data analysis) (Q4-2, Fig. 9), troubles are equally related to each category except for the operation of an apparatus. Although “damage” and “calibration of depth scale” are picked up as others, they can be categorized into “reference samples”, “optimum measurement conditions”, or “data analysis”.

In many affiliations, they use and/or want to use other organizations to help them to overcome above problems instead of solving problems by themselves (Q4-3, Fig. 10). Among such organizations, they believe that SASJ is one of the most potential organizations (fig. 10) and can provide solutions for their problems (Q5-1, Fig. 11). Roles played by SASJ must be important and, at the same time, responsibilities of SASJ is large as well. Therefore, since SASJ is organized by volunteers of SASJ members, contributions of SASJ members are essential for the organization of SASJ.

When the region of expectations for SASJ is limited to DP (Q5-2, Fig. 12), it is interesting that 50% of expectations are related to the provision of opportunities for discussion including the setup of WG, while 1/4 of expectations are related to collection of information through workshops and tutorial lectures. However, when we see answers summarized as “others”, it is clear that the provision of opportunities for collecting information is strongly requested. In addition, it is found that several SASJ members think that SASJ should deal with SIMS. This seems to be a reasonable request from a view point that SASJ had already setup a TOF-SIMS WG at the time when the questionnaires were performed.

3.3. Q6~7 (Troubles faced in DP and expectation for SASJ)

In Q4~5, we asked about troubles faced during daily analysis and expectations for SASJ as described in section 3.2. In Q6~7, questions were more focused on DP. We asked about future developments required for DP and expectations for SASJ. Note that since Q4~5 and Q6~7 are similar, some of responses are duplicated.

In Q6 (Fig. 13), we asked about further developments required for practical DP analysis. It is found that all items were equally requested. The most interesting point

is that not only improvements related to physical phenomena such as a reduction of the sample damage and calibration of the depth scale but also further developments in both equipment and data analysis were strongly requested. In addition, an expectations to overcome charging problems was picked up in "others" as confirmed in Q4-2, indicating that charging is still an important issue in the field of surface analysis and to be discussed in SASJ.

In Q7, expectations for SASJ, which are related to DP, were investigated in the free description format. Expectations covers a wide range of problems. The most important thing is that members recognize SASJ as a society, where they can obtain information related to practical surface analysis, and they expect it in the future as well. This is a key tendency to organize workshops and WGs to overcome problems faced in daily practical analysis.

3.4. Q8~9 (Expectation for SASJ from a view point of surface analysis except for DP)

As observed in section 3.3, a request for charging problems is described as responses for Q8. An expectation as a society for collecting information, which is useful for members' daily analysis, is also strong. In Q9, topics seems to be suitable for a tutorial lecture are investigated. It is easily found that a wide range of requests, from basics to application, e.g., principles of techniques and apparatuses, basics of measurements, methods and know-hows of data analysis, were given. This means that a role expected to be played by SASJ is so important. At the same time, these comments revealed that we should pay attention to the fact that measurements can be easily carried out without understanding principles of techniques and apparatuses because of highly-developed equipment.

4. Summary

In this report, we summarized the questionnaire survey for DP in order to provide information about general issues in DP and needs from practical analysis. As expected, a diverse range of comments and questions were given, indicating that there are still many kinds of problems faced in daily practical analysis in industries. For overcoming the problems, it is very important to provide not only information useful for practical analysis

but also opportunities to enhance discussion among SASJ members.

From a view point of the development of ISO standards, there seems to be many items to be taken into account to improve traceability in DP. Recent activities in ISO/TC 201/SC 4 deal with non-destructive depth profiling using ion beam technique, quantitative compositional sputter DP, and depth resolution parameters. Form the present questionnaires, it is found that these topics are issues strongly related to problems faced in practical analysis and the development of appropriate ISO standards related to those topics are requested. In ISO/TC201 and SASJ, one of authors (T.N.) performed questionnaires related to depth resolution parameters to investigate the practical usages of parameters. In the questionnaires, strong requests from a view point of practical surface analysis in industries were collected and they must be fruitful for the development of an ISO standard dealing with depth resolution parameters. The report of the questionnaire survey for depth resolution parameters is under preparation and will be published shortly.

5. Acknowledgements

This questionnaires were carried out during PSA'07 conference and we acknowledges all of respondents for their cooperation by providing responses within a short period of PSA'07 conference. We also thank Dr. S. Tanuma (NIMS) and Dr. S. Hashimoto (JFE Techno-Research) for providing useful comments during the preparation of the questionnaires.

6. References

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^{†3} Ref. [1] covers basics of most of analytical techniques described in this paper.

Appendix

Questionnaires for depth profiling

Q1: How frequently do you perform DP?

- Frequently
- Sometimes
- Rarely
- Not at all

Q2-1: If you selected options of “frequently”, “sometimes”, or “rarely” in Q1, select analytical techniques, which you use in daily analysis, listed below (multiple answers are acceptable).

✓ Non-destructive DP:

- Angle-resolved XPS
- RBS or MEIS
- XRR,
- Ellipsometry
- XPS background analysis such as Tougaard method
- Others ()

✓ Destructive DP:

- XPS/AES sputter depth profiling
- SIMS,
- AES/XPS/EPMA with pretreatment for cross-sectioning/inclined polishing
- GDS
- Cross-sectional TEM/TEELS
- Others

Q2-2: If you chose options of “frequently”, “sometimes”, or “rarely” in Q1, mark options relevant to depth range that you treat in daily analysis (multiple answers are acceptable).

- A few atomic layers of outermost surface
- < 2~3 nm
- < 10 nm
- < 100 nm
- < 1 μm
- ≥ 1 μm

Q2-3: If you marked options of “frequently”, “sometimes”, or “rarely” in Q1, how much the spatial resolution do you need in daily analysis (multiple answers are acceptable)?

- < 10 nm
- < 100 nm

- < 1 μm
- < 10 μm
- < 100 μm
- \geq 100 μm

Q3-1: : If you selected options of “rarely” or “not at all” in Q1, what is the present status of requests to perform DP ?

- No request for DP at all (or very few)
- There are requests for DP but its priority is lower than other type of analysis

Q3-2: If you chose options of “rarely” or “not at all” in Q1, what is the reason for that (multiple answers are acceptable)?

- Hardware related issue such as resolutions (e.g.,)
- Issues related to analytical techniques or data analysis (e.g.)
- No request for DP for samples to be analyzed

Q4-1: If you have been using DP or are going to use DP in the near future, do you face to or expect any troubles in practical daily analysis?

- Frequently
- Sometimes
- Not at all

Q4-2: If you mark options of “frequently” or “sometimes” in Q4-1, what kind of troubles and concerns do you have (multiple answers are acceptable)?

- Selection of an analytical technique and/or combination of techniques
- Pretreatment of samples
- Selection and/or preparation of a reference sample
- Determination of optimum measurement condition
- Operation procedure of apparatus
- Data analysis
- Other ()

Q4-3: If you described any troubles in Q4-2, how do you overcome such problems (multiple answers are acceptable)?

- By yourself or with your colleagues in your affiliation
- Consult with experts in other affiliation

- Use outsourcing companies having know-how about the problem
- Expect that you get solutions from SASJ
- Expect that you get solutions from societies other than SASJ
- Others ()

Q5-1: If you selected “Expect that you get solutions from SASJ” in Q4-3, how much do you think current SASJ gives you solutions to overcome problems?

- SASJ provides solutions enough at present
- SASJ does not provide solution enough but can overcome problems by applying ideas
- Difficult to solve problems at present

Q5-2: If you marked options of “SASJ provides solutions enough at present” or “SASJ do not provide solution enough but can overcome problems by applying ideas” in Q5-1, what activities do you expect for SASJ (multiple answers are acceptable)?

- Holding workshop related to bland new techniques of DP
- Tutorial lectures on DP
- Providing opportunities to freely discuss about problems of DP faced in practical analysis
- Setting up working groups in SASJ to discuss about problems of DP
- Ask manufactures of analytical equipments to provide information relating to DP
- Others ()

Q5-3: If you select an option of “Difficult to solve problems at present” in Q5-1, describe the reason why you think so.

Q6: What do you expect for the development in analytical techniques for DP?

- Hardware
 - Improvement in depth resolution
 - Improvement of sensitivity
 - Improvement in spatial resolution
 - Further automation of operation of equipment
 - Reduction of sputtering damage
- Software
 - Development of data analysis software
 - Database construction

Others

()

Q7: What do you expect for SASJ from a view point of DP?

Q8: What do you expect for SASJ from a view point of surface analysis except for DP?

Q9: What kind of topics do you want as a tutorial lecture? We would appreciate if you give your answer from a view point of the improvement in analysis techniques and/or growth of young engineers for practical analysis. The topics are not limited to DP and those related to other analysis are welcome.

Q10: What is category of your business?

Manufacture

Your division:

R&D Quality assurance

Analysis Others

Field of your company's productions:

()

Outsourcing of analysis

Manufacture of analytical equipment

Public institute

University/educational institution

Student

Others ()

Discussions and Q&A with the reviewers

Reviewer #1 Mineharu Suzuki (Tsukuba University)

[Q1_1]

In this decade after collecting these ones in 2007, the industrial business structure has been drastically changing in the world and new technology such like an ion cluster sputtering has been developed/commercialized in surface analysis as well. Then I am wondering some parts of this report whether do not match the actual present status.

[A1_1]

I agree with a part of your comments. Therefore, I had already added footnotes to the manuscript. For instance: “†1 At the time when the questionnaires were performed, only a C₆₀ ion source was commercially available for this type of experiment.” in page 5 and “†2At the time when the questionnaire was performed, only a C60 ion source was commercially available.” in page 8.

However, I have different idea about this point. I moved to a private company about four years ago. I really found that most of general issues of DP in practical analysis have not changed so much for these last ten years. Of course, performance of equipments have been significantly improved but many issues are still unresolved and remained. That is why I summarized this report without changing from the original Japanese version and only added a few footnotes. I believe that these issues should be reflected to the development of ISO standards and this helps real improvement of a DP technique in industry.

[Q1_2]

Reading the result that one wants to take an analytical know-how for her/his own specimen at SASJ, I guess (1) no adviser is in her/his organization, (2) no local (organization's) standard description exists, (3) a local (organization's) standardized measurement technique is not taken over, and (4) correct knowledges are needed not only on depth profiling but also on surface analysis such as sensitivity factor, instrumentation, and so on. I am expecting SASJ activities to meet these requirements, though it is not easy. Also I hope ISO/ TC 201/ SC 4 creates the standards on indispensable and essential

subjects in depth profiling prior to standardization of an individual analysis method.

[A1_2]

Thank you very much for your comments. I completely accepted your comments as a message from a former vice-president of SASJ and a previous chair of ISO/TC 201/SC 4.

Reviewer #2 Shigeo Tanuma (NIMS)

(Editor: The reviewer shortly encouraged to publish this report and suggested references in Japanese.)

査読者 2. 田沼繁夫 (物質・材料研究機構)

DP のアンケート結果とそれに基づく結果の報告で有り、SASJ の活動の成果報告としても大変に重要で有り、出版を薦める。

本報告は論文ではないので、内容をより分かりやすくするために、下記の項目については検討されたい。

[査読者 2-1]DP の説明

この説明は簡潔で良いが、初心者や入門者を考えれば、より適当な文献、若しくは本を参考文献につけるべきではないでしょうか。同様に AES, XPS 等もここでは DP との複合で語られているので、これには適当な本(若しくは文献)を紹介すべきでは、AR-XPS も同じです。

[著者]

貴重なコメント、ありがとうございます。以下の通り回答いたしますので、再度ご検討のほど、よろしくお願いいたします。

ここでは多くの表面分析法が関係するため、広く表面分析法を取り扱った教科書の一つである「D. J. O' Connor, B. A. Sexton, and R. St. C. Smart, "Surface Analysis Methods in Materials Science", Springer-Verlag Berlin Heidelberg, 1992」を文献[1]として引用いたしました。

[査読者 2-2]HAXPES

これは(比較的)新しい技術なので文献等を引用しておくべきでは。若しくは引用で参考になる本を紹介しては。

たとえば, "J. C. Woicik ed., Hard X-ray

Photoelectron Spectroscopy (HAXPES), 2016, New York: Springer. は HAXPES 全般をコンパクトに紹介しており、推薦できる” など、など。(題名だけでもいいのですが)

[著者]

ご紹介いただいた教科書を文献[2]として引用いたしました。