Vibrational Spectroscopy of Active Ingredients within Skincare Products

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This report provides a summary of experimental characterizations of the interaction of active ingredients in creams for skincare within synthetic skin foils. Experiments included two vibrational spectroscopies, namely Inelastic Neutron Scattering (INS) and micro-Raman, the former to obtain a bulk information about the interaction of the active ingredient and the cream with the synthetic skin matrix, the latter to map the diffusion of the active ingredient within the synthetic skin as a function of depth with respect to the face where the cream was applied.

Neutron measurements at ISIS - RB2255009

Product code	**Product description**	**TOSCA Run #**
Sample #1	Base cream	27862-27865
Sample #6	Vita-D like 10%	27866-27871
Sample #4	Avocare 0,5% + Tocopherol 5%	27872-27879
Blank	Empty Al container	27881-27886

Table 1 Samples measured at ISIS

Inelastic Neutron Scattering experiments at ISIS were performed at the TOSCA spectrometer. Samples from Table 1 were measured in flat aluminium containers and at base temperature (T < 25 K) to minimise the effect of the Debye-Waller factor and thermal occupation of overtone modes. Several runs were collected for each sample and then summed together and shown in the next Figures 1-2. The run numbers associated to the TOSCA measurements for each sample are reported in Table 1.

Samples were composed of cream with and without active ingredients, according to table 1, applied on synthetic skin foils from Strat-M[1]. The foils had a thickness value of 300 micrometre and a radius of 2.5 cm.

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[1] Membrana Strat-M®, modello per test di diffusione transdermica, 25 mm Strat-M®, filter diam. 25 mm | Sigma-Aldrich (sigmaaldrich.com)

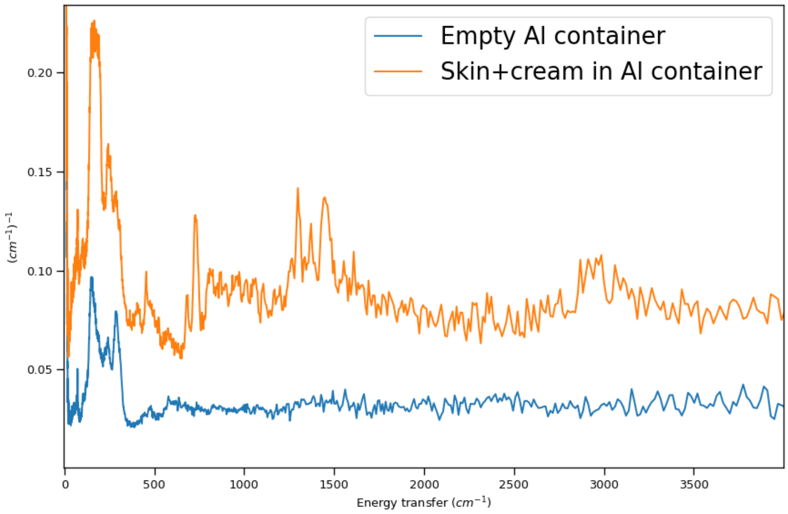

Figure 1 Comparison of empty container and base (without active ingredient) cream applied to synthetic skin foil.

Figure 1 shows the comparison of the relative intensities of the empty container compared to the base cream applied to the synthetic skin foil, that is the base cream without the addition of active ingredients. Compared to the empty aluminium container, Figure 1 shows a significant signal from Inelastic Neutron Scattering (INS) from hydrogen atoms both in the cream and in the synthetic skin foil, as expected.

Figure 2 shows a comparison between the base cream sample (sample 1) and a sample with the addition of the active ingredient. The figure also shows the difference of the two spectra. In particular, sample 4 contained the active ingredient Avocare in the quantity of 0.5 wt% as well as Tocopherol 5 wt%. Here mass percentages are in relation to the mass of the cream applied to the synthetic skin foil. Tocopherol was used in the sample preparation as a tracking agent, for it has a clear vibrational signature. By looking at the two samples, as well as at the difference, it is not possible to obtain a clear spectrum of the active ingredient, nor of the tracking agent.

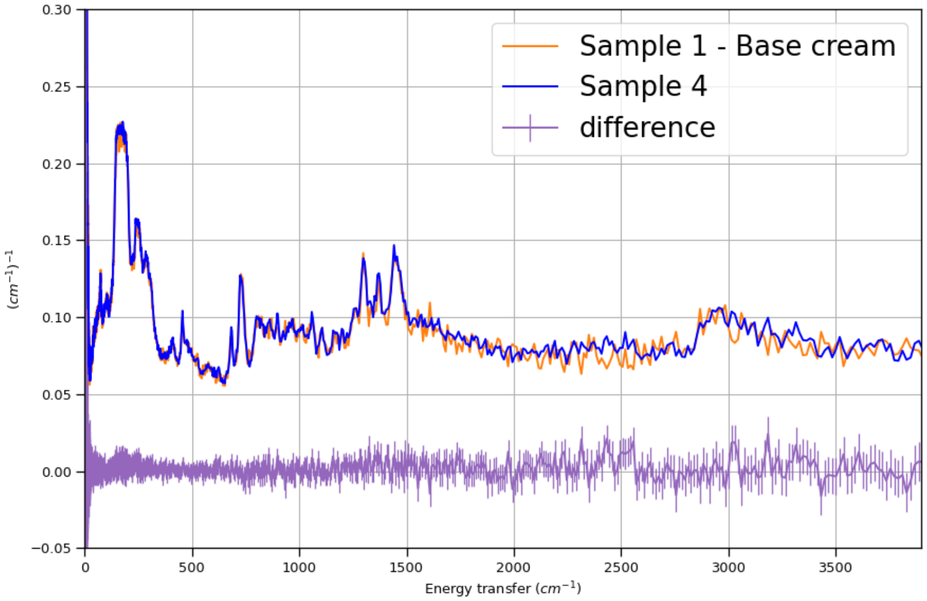

Figure 2 INS spectra of the base cream sample compared to sample 4, containing Avocare 0.5% + Tocopherol 5%.

Raman measurements at IM@IT – GP2022009

Measurements were performed on samples identical in shape to those prepared for the neutron experiment. A summary of the samples measured is reported in Table 2.

Product code	Product description	Laser wavelength [nm] / intensity
Sample #1	Base cream	638 / 10%
Sample #2	Vita AvoCare 5%	638, 785 / 10%
Sample #3	Vita AvoCare 10%	638 / 10%
Sample #4	Tocopherol 5%	638 / 10%
Sample #5	Tocopherol 10%	638 / 10%
Sample #6	Tocopherol in myr 5%	638 / 10%

Table 2 Samples for the Raman measurements

Samples showed a large signal from fluorescence, which provided an intense background to the Raman data. The data acquisition optimization went to the test of several laser frequencies and laser intensities, in order to obtain good-quality spectra. As a result of several tests, the best parameters were set to have a laser relative intensity of 10% and a wavelength of 638 nm. A comparison of the spectra, after subtraction of the fluorescence background, for sample 2 at two different wavelengths of 638 nm and 785 nm is provided in Figure 3, showing how the better quality of the spectra with the former wavelength compared to the latter.

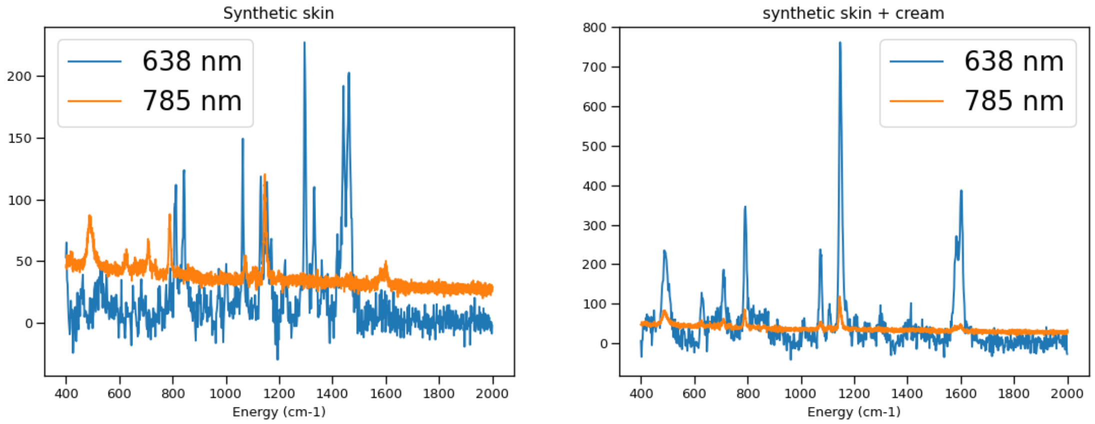

Figure 3 Raman spectra of sample 2, on the side/back (no cream, left panel) and at the center (wjth cream, right panel). Spectra are reported for two laser wavelength tested.

All samples had the cream applied at the centre of one of the two faces of the synthetic skin foil. In order to have a comparison of the spectra from the cream absorbed in the foil or the foil alone, data were collected at the centre of the treated face or the back/side, respectively. A comparison of the spectra from skin + cream (centre of the treated face) and skin alone (side) is provided in Figure 4.

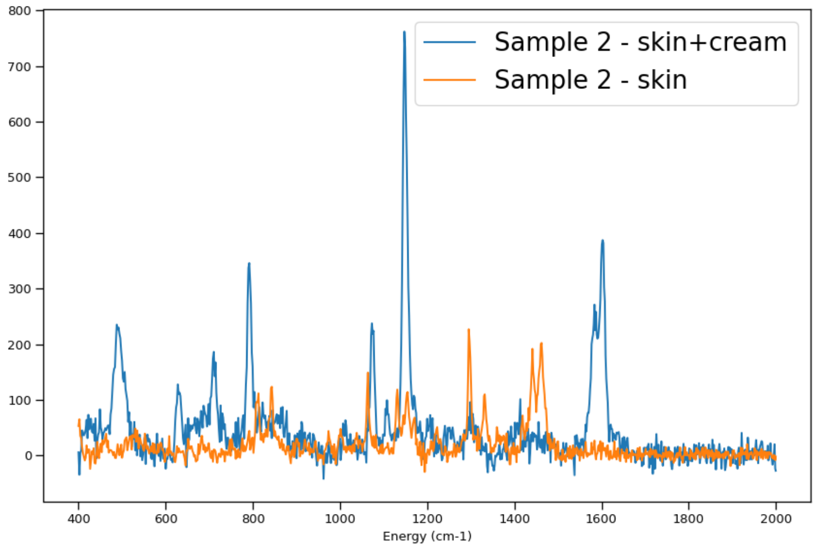

Figure 4 Raman spectra from sample 2 from the centre of the treated face, with signal from both skin and cream, and from the side of the skin face, not including any signal from the cream.

The analysis of Figure 4 shows that the spectra of the synthetic skin and of the cream are markedly different. Moreover, when collecting data from the treated face of the synthetic skin, one can safely assume that all the intensity is related to the cream, as the two spectra do not present peaks in common. On this basis, it is in principle possible to design an experiment whereby the diffusion of the cream at several depths within the hosting synthetic skin can be measured using Raman microscopy.

While the comparison of skin and cream provides marked differences, the spectra from the several samples measured can be considered equal within the experimental error bars. Such a comparison is provided in Figure 5 for samples 1 – 4 (see Table 2). These samples include different amounts of the active ingredient Vita AvoCare (up to 10wt%) and of Tocopherol (up to wt5%).

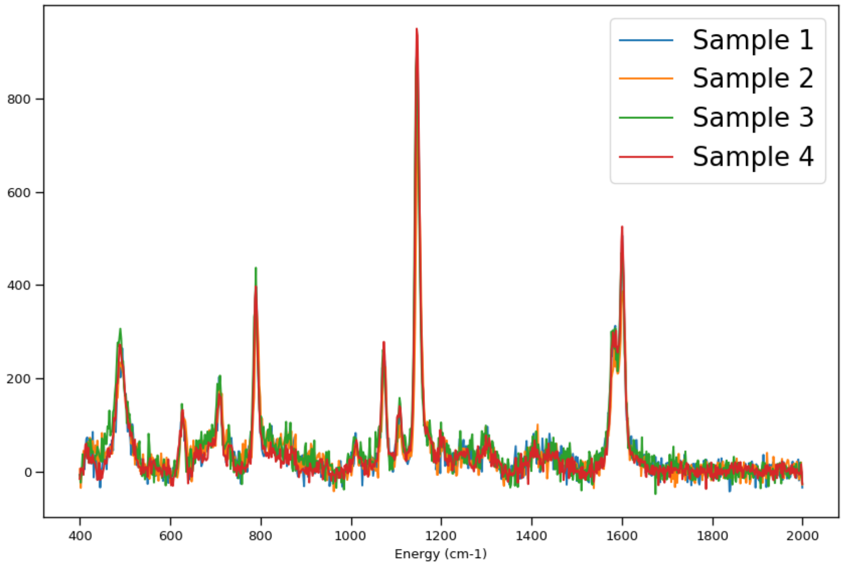

Figure 5 Comparison of Raman spectra from several samples investigated, from the center of the treated face therefore corresponding to both skin and sample signals.

Conclusions

Experiments based on vibrational spectroscopy, either INS or Raman, provided a clear signal from both the synthetic skin foil and base cream. INS provided an average signal from these two components, being a bulk technique, while Raman showed a marked position sensitivity, showing clear differences between the region where the cream was applied and the region where it was absent.

However, so far it was not possible to collect an appreciable signal from the active component, neither using INS nor Raman, probably because the amount was below the detection limit of the technique in these experimental conditions. The same applies to the tracking agent used, Tocopherol.