Methods of research and monitoring of objects at risk in collections

Methods of research

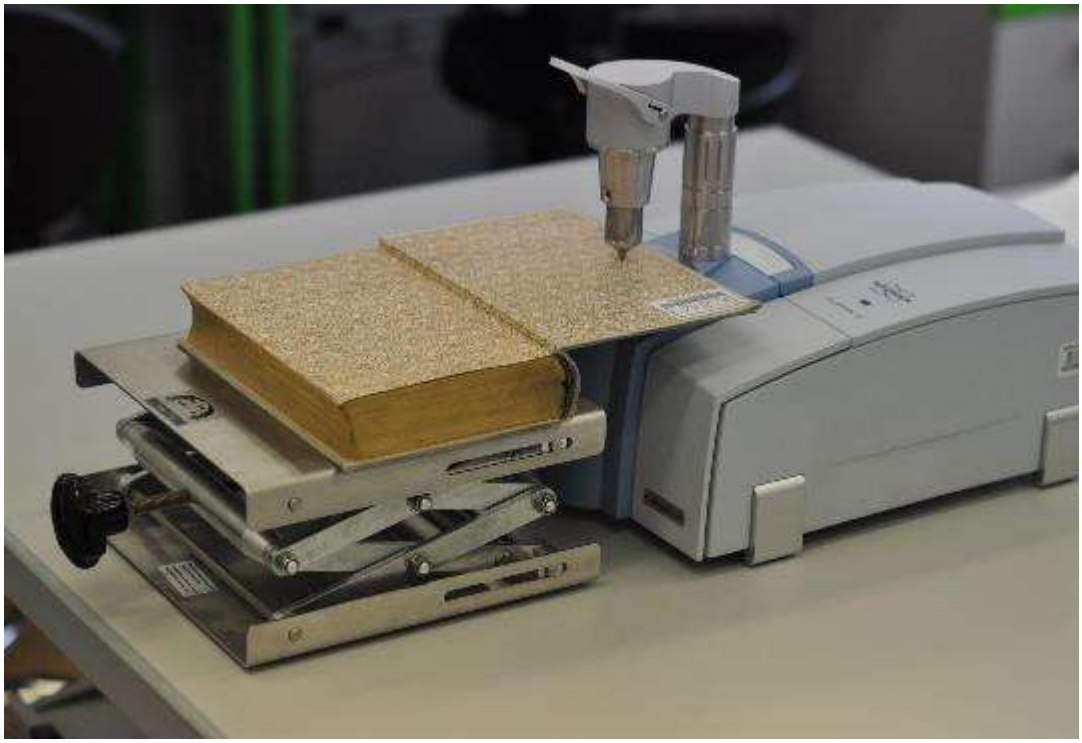
The identification of synthetic materials on the book bindings of the library collection of the National Library of the Czech Republic is carried out exclusively by means of non-destructive analyses. Based on experience, the type of synthetic material can be determined e.g. visually, by touch or smell. This so-called non-instrumental evaluation uses the typical properties of each type of plastic such as appearance, hardness, flexibility, sound when tapped with the fingernails, or odour. Due to the possible presence of various additives in plastics that affect their properties, a visual assessment may give incorrect information. Correct determination of the type of plastic can be made by microchemical (microdestructive) methods or ideally by non-destructive instrumental methods.

Instrumental methods

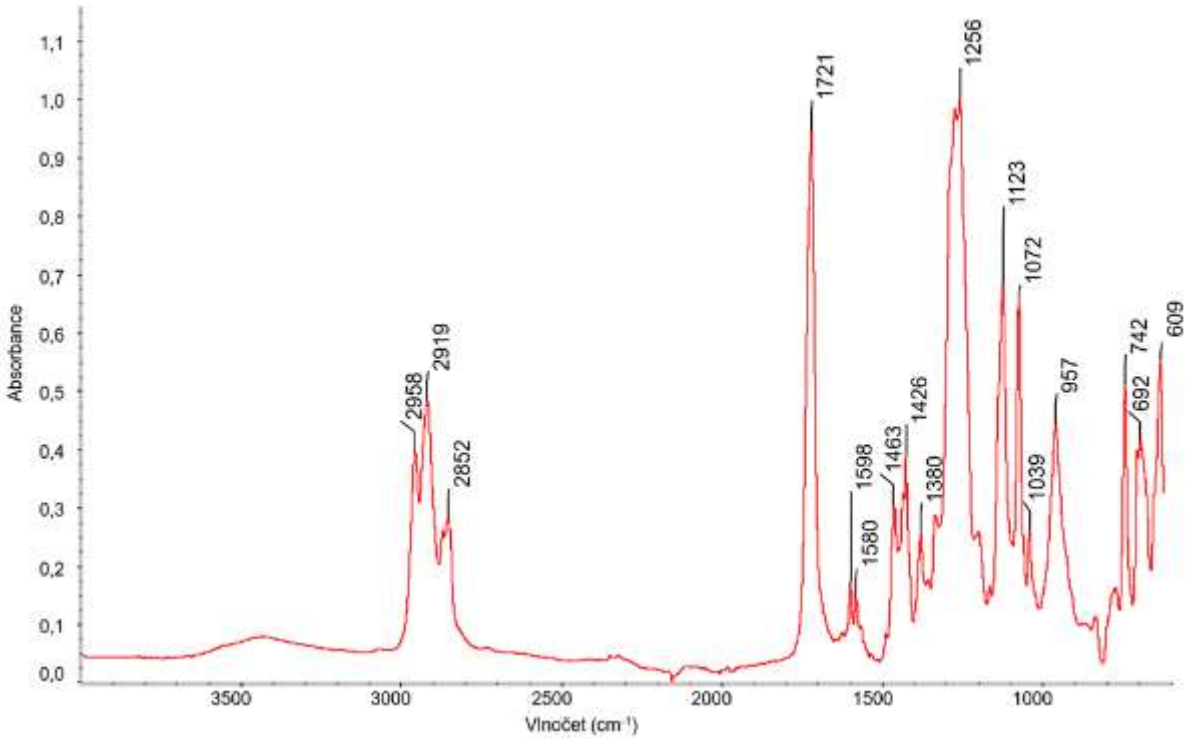
Infrared spectroscopy

For measurements in mid-infrared spectroscopy, the National Library of the Czech Republic is equipped with a Bruker Alpha II Fourier Transform Infrared (FTIR) spectrometer. It is a compact, easily portable FTIR spectrometer equipped with several modules for transmission and reflection modes. The module using the attenuated total reflection (ATR) technique is the most widely used. This technique is particularly popular due to the high quality spectra with little or no sample preparation required.

Measurement arrangement using the reflection module of the Bruker Alpha II infrared spectrometer



Arrangement of book plate measurements with the ATR module of the Bruker Alpha II infrared spectrometer



Infrared spectrum of phthalate-softened PVC measured by ATR (ATR-FTIR)

SurveNIR

For the identification of materials in the near-infrared region, the SurveNIR system is used in the National Library of the Czech Republic. The system can identify 45 types of polymers. The surface of plastics is usually treated in the final stage of production, for example by painting and dyeing, which may make identification by SurveNIR difficult, which in such cases is indicative only and should be complemented by further investigation. The advantage of SurveNIR is its speed and ease of use.

SurveyNIR measurement system

The survey focused on the identification of plastic materials in the two largest and key collections of the National Library, the National Conservation Fund (NCF) and the Universal Library Fund (ULF). For each specimen, a record was created in the database of the survey of the physical condition of the library collection maintained in the Central Knowledge Base of the Digitization Register (hereinafter referred to as Agenda). The Agenda enables the recording of the actual physical condition of the library pieces - book binding design, material composition and detailed description of any damage. Visual documentation, reports from analyses, measurements, etc. can also be added to the Agenda. Based on the results of such a detailed survey, it is then possible to statistically evaluate the types of damage, diagnose its causes and propose possible solutions.

In the NCF, documents were selected by the fund administration staff on the basis of the presence of synthetic material, either directly as the plastic mechanical binding, packaging/covering material, or in the form of enclosed objects (floppy disks, CD covers, toys). Of the plastics, plasticized polyvinyl chloride (PVC-P) was the most common, particularly in the form of an artificial leather coating material for board or in the form of transparent foils and packaging; and unplasticized polyvinyl chloride (PVC-U) in the form of plastic mechanical bonds (combs, spirals…). Using the FTIR analysis, the laminations were mostly determined

as polypropylene (PP) or phthalate polyester (PES), low density polyethylene (PE-LD) was identified for plastic packaging, and in the case of plastics with lower representation (ABS, PA, PS…) it was usually plastic applications on boards or on toys and other attachments.

NCF fund - books in the shape of cars - cardboard laminated with phthalate polyester with ABS wheels. The books are stored in a transparent PVC plastic bed in a box laminated with polypropylene.

In the ULF, the survey was carried out mainly on the press mark series 54 H. The survey was carried out in the depository, so that the selection of books could be made directly by the survey staff. In 2021 alone, over 2,904 books were examined here. Typologically, the sample of books examined was not as diverse as in the NCF. Most books were hardback with laminated full paper covers (V8a). Cased binding books with unreinforced plastic covers were a significant minority (V9a). Several books had half-linen bindings with laminated paper on the boards. Bindings with plastic binding screws and plastic covers made of transparent film were more likely to occur rarely.

In 2021, 131 specimens from the 54 K press mark series were identified in ULF. The selection was made by the survey staff according to a visual assessment - the aim was to find less common synthetic materials and identify them. Most of them were children's books with plastic applications on the boards or the included toys. The books were newly included in the collection and carried no serious damage, with the year of publication mostly 2010 - 2020.

The most common plastic covers were polypropylene (PP), all-plastic waterproof books made of either high density polyethylene (PE-HD) or ethylene vinyl acetate (EVAC), books with foam sheets made of low density polyethylene (PE-LD), textile-sheet books and plush toys made of polyethylene terephthalate (PET), and rubber water toys made of plasticized polyvinyl chloride

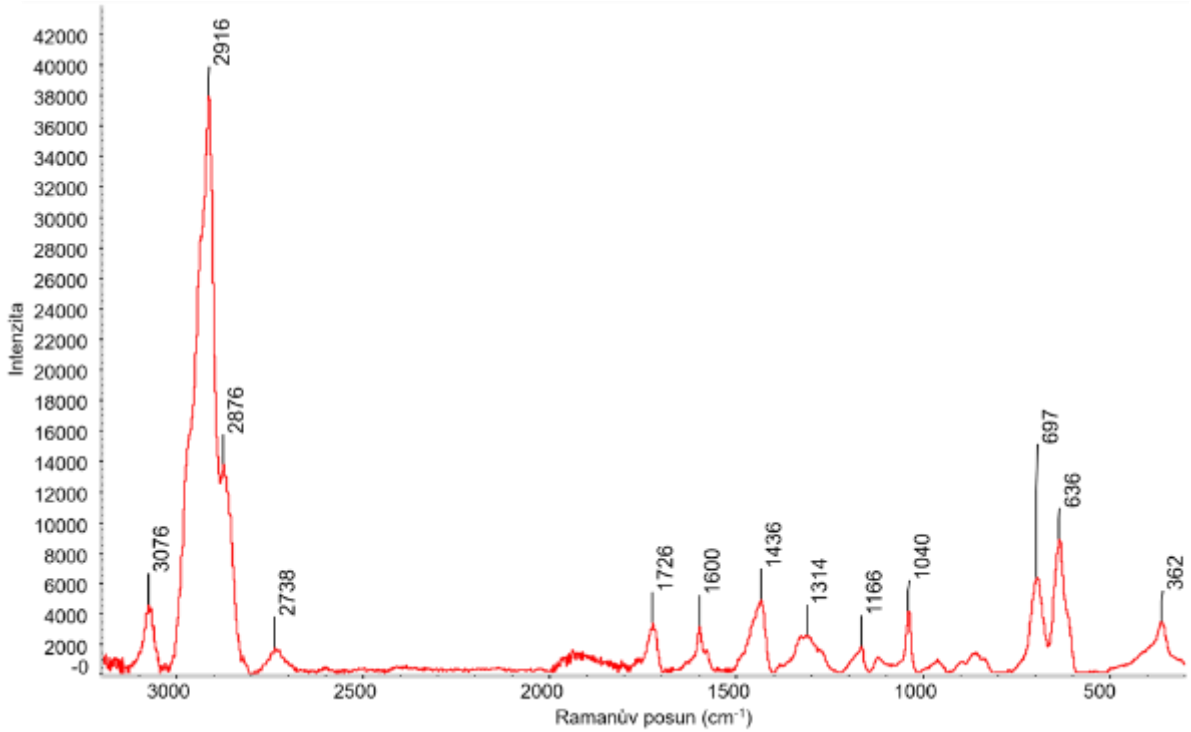
(PVC-P). Other plastics with lower representation (PMMA, ABS, EPDM, PA, PS…) occurred in applications on boards (ears, lugs, studs…) and in the enclosed toys.

Books from the ULF press mark 54K. Ladybug-shaped book with plastic antennae - black part made of polypropylene, red stem made of PET (left) and book with textile sheets made of polyester fibre with soft polyurethane filling in original transparent polypropylene plastic cover (right)

Raman spectroscopy

The Development and Research Laboratories Department of the National Library of the Czech Republic has a Bruker Bravo handheld dispersive Raman spectrometer. The device has a built-in battery and uses two lasers with a wavelength of 700-1100 nm for measurement. The resulting spectrum is then composed of two parts belonging to a given laser. Due to the two lasers, Bruker Bravo provides quality spectra in the spectral range of 3200-300 cm^{-1}. Another unique feature of the Bruker Bravo device is the automatic and effective suppression of the fluorescence phenomenon, which contributes to a more reliable identification of the measured material. Within a few seconds, it is possible to identify the composition of book bindings, illuminated manuscripts, corrosion products, etc.

Bruker Bravo Raman spectrometer in book cover composition analysis



Raman spectrum of PVC softened with phthalates