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IDENTIFICATION AND SORTING OF MATERIALS WITH PORTABLE LIBS BEFORE DECOMMISSIONING

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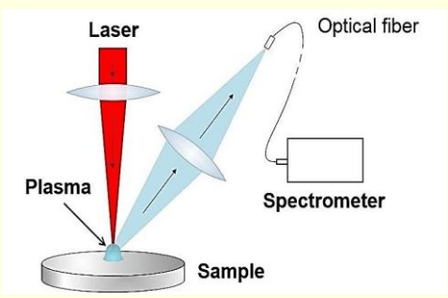
Laser induced breakdown spectroscopy (LIBS) is a fully optical, multi-elemental and fast analytical technique, requiring no or little sample preparation. These features make the LIBS technique particularly suited for on-site measurements. Due to the current development of handheld LIBS instruments, on-site LIBS analysis applications are emerging. In this study, LIBS analysis is applied to the on-site identification of materials to meet the needs of waste sorting in industrial domain and in nuclear domain (inventory before decommissioning).

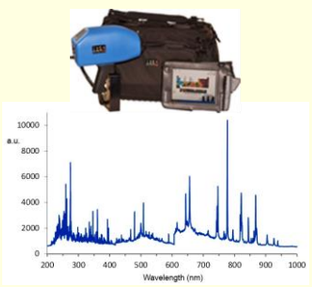
Principle, instrument and experiment

LIBS principle



A laser beam focused on the sample surface creates a plasma formed by the atomized compounds. The light emitted by the plasma is analyzed by an optical spectrometer.

Portable instrument



On-site fast analysis:

Methodology

A database of spectra is built using reference samples belonging to four categories (classes) of industrial interest (1 laser shot per spectrum and 10 spectra per sample):

Classes of samples of level 1		Sub-classes (levels 2 and 3) *	
Name	Number of samples	Level 2	Level 3 (if necessary)
Alloy	126	Ex.: steel	Ex.: stainless steel, maraging steel,…
Plastic	70	Ex.: polyethylen PE	Ex.: PE-HD, PE-BD…
Glasses	43	Ex.: MgF2	
Concrete	5	Ex.: CEM1	

* *sub-classification to be reached*

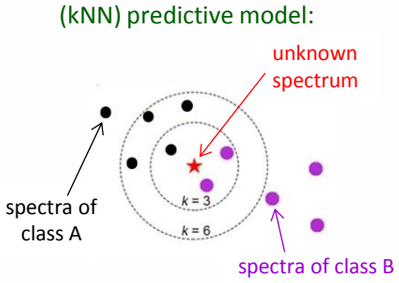
Predictive statistical models of the classes and sub-classes are calculated. With these models, predictions of classes and sub-classes of unknown materials are made.

Data treatement and identification tests

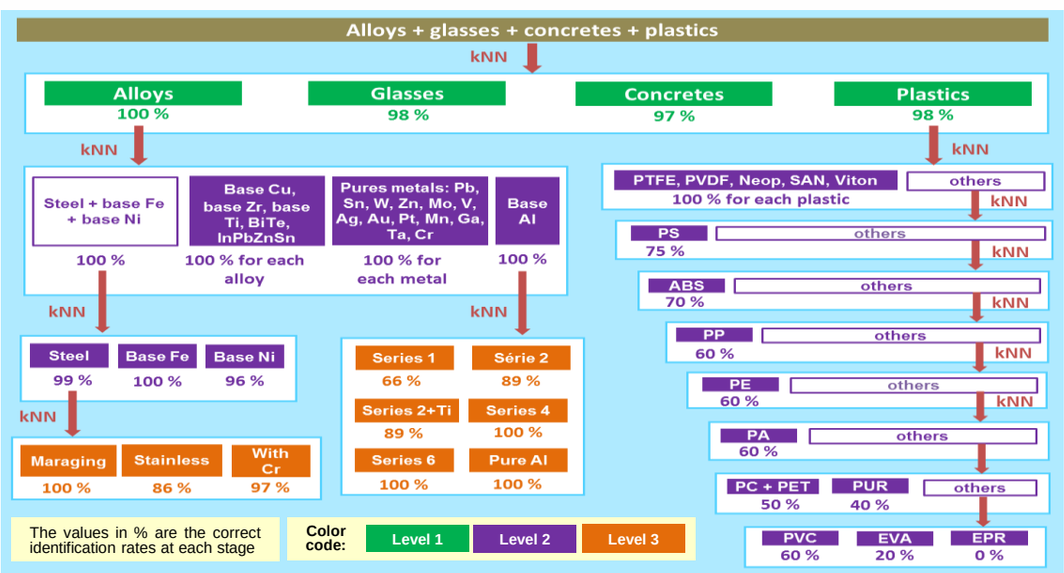
Predictive models are calculated and, at each stage, identification tests are made and the correct identification rates are evaluated in %.

An integrated software module has been designed and implemented in the instrument software to build the models and to calculate the correct identification rates.

Principle of k-nearest neighbors (kNN) predictive model:



In the example shown above, the unknown spectrum (red star) is assigned to class A for k=6 and to class B for k=3.



For alloys, sub-classes of levels 2 and 3 are identified with very satisfying rates. Plastics are more difficult to identify because their elemental composition is very similar from one material to the other. However, the correct identification rates obtained at the level 2 are encouraging even if they still have to be improved for some materials of interest (e.g. ABS, PS, PVC).

This study demonstrates the ability of portable LIBS to perform on-site identification of material for waste sorting or inventory before decommissioning.

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