From metallic clusters to nanoalloys: the legacy of Jacques Friedel

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Metallic clusters have been one of the numerous legacies that Jacques Friedel transmitted to our community. Actually, he organized for the first time in 1976 the International Meeting of Small Particles and Inorganic Clusters[1] in Lyon and wrote four years later the concluding remarks of the second edition[2] in Lausanne in 1980. It has become the well-known ISSPIC conference which has been held every four years until 1988 (Berlin, chairs: Benneman, Koutecky and Aix-en-Provence, chairs: Friedel, Gillet) and every two years since 1990. The next one, ISSPIC XVIII, will take place in Finland, in August 2016, organized by Hakkinen.

Jacques Friedel was interested in the structure of the matter lying between the atomic or molecular physics, and that of macroscopic condensed matter. This is properly the clusters world where he also distinguished two domains according to the size of the clusters, as he wrote[1]:

- "In *microclusters* of typically less than a few 100 atoms (…) the nature of interatomic, i.e. the *electronic structure*, can vary rapidly with size and shape."
- "In *larger clusters*, one can define 'surface' and 'volume' atoms; (…) it is essentially the large *surface over volume ratio* which leads to specific properties".

He also wrote in his concluding remarks[2]: "More interdisciplinarity; more potential applications" because he noticed "a better integration of *physicists* and *chemist*s in this field", "a better knowledge and description of the nucleation processes involved in phase change, especially in metallurgy", and finally important applications in catalysis and magnetism.

A direct connection between theory (simulations) and experiments has even been possible thanks to the nice experiments performed in the group of J. Farges and M.-F. De Feraudy[3] in Orsay on rare gas and the group of R. Monot[4] on noble metal clusters in Lausanne who observed by X-ray diffraction the structure of unsupported clusters formed in beam experiments ("clean and isolated clusters in vacuum, a theoretician's dream !", as he wrote[1]). Small closed-packed icosahedral structures were observed at small size and twinned fcc crystals at larger sizes, that where comparable to the one obtained in molecular dynamics simulations.

Increasing the complexity and doing a real connection between cluster and metallurgy, the "nanoalloys" (nanoparticles of alloys, essentially bimetallic clusters) has become a subject of intensive research that we would like to address in this communication.

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3. J. Farges, M.F. De Feraudy, B. Raoult, G. Torchet, J. Chem. Phys. 78, 5067 (1983)
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