

Names and symbols of the elements with atomic numbers 114 and 116 (IUPAC Recommendations 2012)*

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Abstract: A joint IUPAC/IUPAP Working Party (JWP) has confirmed the discovery of the elements with atomic numbers 114 and 116. In accordance with IUPAC procedures, the discoverers proposed names as follows: flerovium with the symbol Fl for the element with $Z = 114$ and livermorium with the symbol Lv for the element with $Z = 116$. The IUPAC Inorganic Chemistry Division recommended these proposals for acceptance, and they were adopted on 23 May 2012 by the IUPAC Bureau as delegated to act by the IUPAC Council meeting on 3–4 August 2011.

Keywords: element 114; element 116; element name; Fl; flerovium; livermorium; Lv; IUPAC Inorganic Chemistry Division; periodic table.

INTRODUCTION

In 2005, a joint working party (JWP) of independent experts drawn from IUPAC and IUPAP was appointed by the Presidents of the Unions to determine priority of claims to the discovery of elements with atomic numbers greater than 111. This JWP first considered the literature and documentation submitted to it by 30 June 2007. All of its deliberations were carried out in accordance with the criteria for the discovery of elements previously established by the 1992 IUPAC/IUPAP Transfermium Working Group [1–3] and reinforced in subsequent IUPAC/IUPAP JWP discussions. The group first reported [4] on the discovery of the element with atomic number 112, and this element was subsequently named copernicium with the symbol Cn [5]. The group then extended the deadline for the receipt of documentation to 31 July 2008 and issued a second report [6] in which the discovery of the elements with atomic numbers 114 and 116 was assigned to collaborative work between scientists from the Joint Institute for Nuclear Research in Dubna, Russia and from Lawrence Livermore National Laboratory, California, USA (the Dubna–Livermore collaborations). Prior to its publication, this report was sent to each of the claimant laboratories to be checked for technical accuracy. It was also reviewed by eight independent expert referees, and its findings were accepted by the Executive Committees of the two Unions and by the Division Committee of the IUPAC Inorganic Chemistry Division.

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RECOMMENDATION

The 2011 JWP report [6] concluded that “the establishment of the identity of the isotope ^{283}Cn by a large number of decaying chains, originating from a variety of production pathways essentially triangulating its A, Z character enables that nuclide’s use in unequivocally recognizing higher- Z isotopes that are observed to decay through it.” From the 2004 Dubna-Livermore collaborations, the JWP noted: (i) the internal redundancy and extended decay chain sequence for identification of $Z = 287$ 114 from $^{48}\text{Ca} + ^{242}\text{Pu}$ fusion [7,8]; and (ii) that the report of the production of $^{291}116$ from the fusion of ^{48}Ca with ^{245}Cm [9] is supported by extended decay chains that include, again, ^{283}Cn and descendants. The JWP recommended that the Dubna-Livermore collaborations be credited with discovery of these two new elements. A full synopsis of the relevant experiments and related efforts is presented in the technical report [6] published online in *Pure and Applied Chemistry* on 1 June 2011.

Following the assignment and in accordance with the procedures established by IUPAC for the naming of elements [10], the discoverers at Dubna and Livermore were invited to propose names and symbols for the elements with atomic numbers 114 and 116.

For the element with atomic number 114, the discoverers proposed the name flerovium and the symbol Fl. This proposal lies within tradition and will honour the Flerov Laboratory of Nuclear Reactions where superheavy elements are synthesised. Georgiy N. Flerov (1913–1990) was a renowned physicist, author of the discovery of the spontaneous fission of uranium (1940, with Konstantin A. Petrzhak), pioneer in heavy-ion physics, and founder of the Laboratory of Nuclear Reactions in the Joint Institute for Nuclear Research (1957). It is an especially appropriate choice because since 1991 this laboratory, in which the element was synthesised, has borne his name. Professor Flerov is also known for his fundamental work in various fields of physics that resulted in the discovery of new phenomena in properties and interactions of the atomic nuclei; these have played a key role in the establishment and development of many areas of further research.

For the element with atomic number 116, the name proposed is livermorium with the symbol Lv. This proposal is again in line with tradition and honours the Lawrence Livermore National Laboratory (1952). A group of researchers from this laboratory along with the heavy element research group of the Flerov Laboratory of Nuclear Reactions took part in the work carried out in Dubna on the synthesis of superheavy elements, including element 116. Over the years, scientists at Livermore have been involved in many areas of nuclear science: the investigation of fission properties of the heaviest elements, including the discovery of bimodal fission; the study of prompt γ -rays emitted from fission fragments following fission; the investigation of isomers and isomeric levels in many nuclei; and the investigation of the chemical properties of the heaviest elements.

The Inorganic Chemistry Division Committee has considered the proposals of the discoverers and recommends to the IUPAC Bureau and Council that the names flerovium with the symbol Fl and livermorium with the symbol Lv for elements with atomic numbers 114 and 116, respectively, be accepted. Provisional recommendations of the names and symbols were made available for review and comment in December 2011. The final recommendation was approved by the IUPAC Bureau on 23 May 2012 as authorized by Council at its meeting of 3–4 August 2011. This followed the statutory period during which the recommendation was open for public comment.

Finally, the reviews of the claims associated with elements 113, 115, and 118 are at this time not conclusive, and the evidence is considered to not meet the criteria for discovery.

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